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XIV.—VARIABILITY OF THE CAMPHOR-YIELD IN CINNAMOMUM CAMPHORA.

S. T. Dunn.

During the last years of the 19th century in consequence of the rising price of camphor and of the increasing demand for it for the manufacture of cellulose, numerous enquiries were addressed to Kew from the warmer parts of the British Empire as to the feasibility of growing the Camphor Tree there and producing remunerative plantations. To circulate information on this subject a paper was published in the *Kew Bulletin* (1899, pp. 57–68), making suggestions for the guidance of intending planters and summarising what had already been done in the camphor-planting industry.

The production of camphor plantations was about that time taken in hand in many parts of the world and camphor was soon being produced from the leaves of the young saplings on the same plan as had been tried with success by Mr. Nock in the Government Gardens at Hakgala, Ceylon. As some of these plantations progressed and attempts were made to extract camphor from the leaves, complaints began to be heard (notably from Dominica, St. Vincent, and Mauritius), that many young trees would not yield anything but oil, from which no solid camphor could be produced. In the case of Mauritius nearly all the plants were " oil-yielding " and it became a question of considerable economic importance how to avoid such disappointing results.

The existence of worthless as well as valuable camphor trees had long been recognised by the camphor distillers in China, Japan, Formosa, Cochin-China and other places where *Cinnamomum Camphora*, Nees, was exploited as a wild or cultivated tree. But now that the same phenomenon was beginning to appear in newly-made plantations it became important to all concerned to discover a remedy.

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Numerous enquiries on the subject began to reach Kew and investigations were immediately instituted. Requests were sent out to the various Colonies where aberrant trees grew, asking that experiments might be made and that botanical specimens and full notes on their plantations might be sent to the Royal Botanic Gardens.

From these notes and from the recorded experiences of former practical exploiters as to the variations in the yield of camphor trees, the following notes have been drawn up as to the best way of establishing paying plantations.

The all-important matter to the camphor exploiter is the proportion of Camphor that a tree yields. The actual percentage of solid camphor obtainable and to a less extent the percentage of the various constituents of the oil—safrol, cineol, eugenol, etc.—determine the value of the tree. Oils are always among the by-products of camphor production, for the solid substance obtained from the distillation of the wood or leaves is invariably mixed with light and heavy essential oils. An "oil tree" is not therefore necessarily one that produces only oil, but one that yields a large proportion of oil, and that does not yield solid camphor in paying quantities.

Before suggesting means of producing plantations of camphor-bearing trees it will be necessary to enquire first into the cause of variation of yield and although the endeavour is now to obtain camphor by the distillation of the leaves, advantage may be taken of the experience of the camphor-wood distillers to throw some light on the cause of variation.

Causes of Variation.

The direct cause of the presence in the camphor tree of essential oils of varying constitution and quantity is to be found probably in the formation within the plant of Terpentinol (C_{10} H_{16}), which is gradually changed by the activity of the living cells into camphor (C_{10} $H_{16}O$). As this oxidization progresses different compounds appear and it is by their admixture in the products of the distillation that all the different oils and finally camphor itself are formed. (Grasmann in *Mitt. Deutch. Gesellsch.* vi. 303 (1895) and Dubard in *Bull. Econ. Indo-Chine*, 1909, 148).

If this theory is accepted, it is not surprising to find that the yield of camphor varies from month to month. Mr. Oishi writing in the *Chemical News* as early as 1884 (l. 74) enumerates a series of measurements to prove that much more camphor is obtained in Japan from camphor wood cut in the cool season than from that cut in the summer. The same observation was made by Mr. W. R. Price, writing from Formosa in 1912, as tending to account for the presence of so-called "oil trees" in that country. The cause of variation in the recorded yield of a tree in the Government plantation at Curepipe in Mauritius is

suggested, it is noticed, by Mr. Tempany to be the time of the year at which the leaves were clipped for distillation. If there is any other circumstance affecting the healthiness and cell activity of *Cinnamomum Camphora* it will on the above theory affect the yield of Camphor. This supposition gains support from Mr. L. A. Boodle's microscopic examination of the specimens of wood from the experimental plantations in Mauritius above referred to :—

" On re-examining No. 6 (from a tree said to yield camphor), fungal filaments were found in certain parts of the wood," he writes, " but were decidedly less abundant than in specimens 3, 4, and 7 (from " oil trees "). It is doubtful to what extent the growth of the fungus in the wood may have taken place after the trees were felled or the specimens were cut, but the distribution of the fungus in the latter rather suggests that the living trees were attacked to some extent. It is suggested as a mere possibility that, in these particular specimens, fungal attack of the wood may have had a deterring effect on the production of camphor, since the sample from a camphor-producing tree (No. 6) shows markedly less fungus than the other three specimens, which are samples of oil-producing trees (3, 4, and 7). Whether fungal disease of the wood is common in Mauritius, and whether it influences camphor production, cannot be satisfactorily dealt with except on the spot."

" In 3, 4, and 7, the secretion in the oil-cells in the wood is mostly yellow, while in 6, the oil-cells either appear empty, or, where a secretion is visible, it is nearly always colourless. This observation quite agrees with No. 6 being a camphor-producing sample, since loss of yellow colour in the secretory cells accompanies the transformation of the oil into camphor (Tschirch, *Die Harze u.d. Härzbehalter*, 1906, vol. 2, p. 1175). On comparing sections from different parts of specimens 3, 4, and 7, it appeared that the presence of yellow secretion in the oil cells was general in regions strongly attacked by a fungus, but that the yellow colour was mostly absent, or rarer, in the sounder portions of the wood."

It is noticed also in this connection that the climatic conditions of N. Formosa seem to favour a plentiful production of solid camphor, whereas in the south, according to a letter from Mr. Takeda written in 1919, many trees yield little solid camphor but large quantities of Sho oil and Yu-ju oil, the trees being known to the Japanese as Sho-gyu and Yu-ju respectively. In the climate of Florida the same species produces solid camphor mixed with an oil differing from the Japanese oils in its low percentage of safrol. (Hood & True in *Yearb. Dept. Agric. U.S.A.*, 1910, 459). Hood and True have shown the remarkable variation of camphor content in the leaves of trees growing under different conditions of shade and soil, and M. K. Bamber in his experiments in Ceylon has found evidence of the same fastidiousness. Mr. Carmody (formerly Director of Agriculture in Trinidad) in the

Times Trade Suppl. April 10, 1920, draws attention to a case in the Trinidad Botanic Gardens where transplanting caused small trees to recover and produce a normal quantity of camphor. From these observations it seems important to consider in the first place the situation most suitable for the camphor-tree and also to find by experiment the best time for clipping the leaves.

But there is another line of enquiry that may lead to useful results, viz. as to the existence of botanically distinct camphor-yielding varieties. One of the chief objects of Kew in obtaining specimens of the trees grown in various colonial plantations was to compare them with examples of the true species of China and Japan, and to determine whether the non-camphor-producing specimens differed in any botanical way from the valuable kind. Mr. Lan (*Bull. Econ. Indo-Chine* 1907, 205) believed that they did so differ, and that a red colour suffused the buds and twigs of the camphor-producing variety, while its absence marked the oil-producing trees. But these indications were admitted by Mr. Crevost in the same journal to be merely due to difference of exposure, and Mr. Eberhardt surmised that they are rather an indication of the degree of the maturity of the tissues than of any inherent peculiarity (*l.c.* 1909, 145). In further criticism of this supposed varietal character, Mr. Joseph Jones, Curator of the Botanic Garden of Dominica, states that even in green-twigged plants the red colour appears in drying. Further observations may prove that the appearance of red colouring, though not a permanent character is a useful indication of the time at which the camphor appears in the leaves. The smell of the crushed leaves is noticed to resemble that of camphor in the trees that yield that substance, whereas the " oil-tree " leaves smell of turpentine or eucalyptus. The Chinese are said to differentiate between the valuable and worthless trees in Formosa by this distinction. Whether this is a permanent character is not quite clear.

In 1912, Mr. W. R. Price collected specimens (*Price* 425) of an " oil-producing tree " growing wild in the forest in Formosa. This proves to be *Cinnamomum Camphora*, Nees, var. *glaucescens*, Braun, differing from the type in the glaucous colour of the under surface of the leaves. The variety was known to Braun as a cultivated tree in Java and in the Botanic Gardens in Berlin, and he described it as giving a smell more of terebinth than camphor. Meissner, however, in his monograph of *Lauraceae* (*DC. Prodr.* xv. 24), reported that the same specimens smelled of pure camphor. The variety has been known in cultivation for a long time, and a very old tree in the Botanic Garden at St. Vincent has the same character of producing no solid camphor.

Besides these two slight colour indications no visible varietal characters can be found in any part of the tree to separate " camphor " trees from " oil " trees. But a further line of endeavour should also be pursued. The occurrence of the so-called oil and camphor-trees side by side in the same wild or

cultivated surroundings suggests that there may be individual peculiarities which affect the chemical products of camphor trees without being accompanied by any corresponding outward characters. Such physiological varieties are known to exist. They were proved for instance by Mr. Whitby in the case of *Hevea brasiliensis* (*Ann. Bot.* xxxiii. 313), and Mr. Gamble in the new edition of his *Manual of Indian Timbers* (p. 297) refers to the existence of similar varieties in *Acacia Catechu*, Willd.[1]

Suggested lines of improvement.

From the statements above it is quite clear that in order to produce plantations of trees that will give good quantities of solid camphor, (1) seed should be secured from trees known to produce camphor. Probably seed of this kind could be obtained from Hongkong, as Mr. Green, in his Report on the Botanical & Forestry Dept. for 1919, refers to the Chinese distilling camphor in various parts of the New Territory. (2) Suitable climate and soil should be selected. (*See* Circular No. 12, published by the Division of Botany of the U.S. Department of Agric. in 1897, reproduced in the *Kew Bulletin*, 1899, 57). (3) Saplings must be planted so that they may be clipped conveniently. The article on camphor cultivation in the United States, in the *Agric. Dept. Yearbook* for 1910 (p. 449–460), part of which is reproduced below, gives exact instructions for forming and using camphor plantations in the climate of Florida, and Circ. 78 (1920) of the same Department describes a machine for harvesting the leaves. A few notes from Bulletin No. 15 of the Department of Agriculture Federated Malay States are added. (4) The best months for clipping must be ascertained by experiment as observations show considerable changes in the camphor content of the leaves as the growing season advances.

Extracts from "*Camphor Cultivation*," by S. C. Hood & R. H. True in *Yearbook Dept. Agric., U.S.A.*, 1910, 453–455.

Propagation.

"Camphor can be propagated by seed, cuttings, and root cuttings, but for commercial purposes the first method is to be preferred, except in cases of special varieties having some valuable characteristic which would not be reproduced by seed. In propagation by seed great care should be taken in the selection of the land for the seed bed. If possible, a rich, well drained soil which has been under cultivation in previous years should be found."

The Seed and Seed Bed.

"Too much emphasis cannot be placed on the preparation of the seed bed, since after the seeds are planted no cultivation can be given for three months."

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[1] See also Chevalier in *Revue de Bot. Appliquée*, i. 20 (1921).

"For convenience in future handling, the seed should be planted on hills 3½ ft. by 1½ ft., with three seeds to the hill, and covered about 2 in. deep. This method will require about 24 quarts of seed per acre and will produce enough trees for setting out 16 acres of field planting."

Cultivation.

"The seeds will begin to come up about three months after planting, but four or five months are often required for a full stand. The percentage of germination is very low and only about one-half the seeds may be expected to grow. Cultivation should begin as soon as possible, and as soon as a full stand is obtained the plants should be thinned to one in a hill and given a good dressing of high-grade fertilizer."

"The first season the plants should make a growth of 12 to 18 in., with a very large and vigorous root system. The treatment the second year should be the same, and at 26 months from planting the plants should be from 2 to 3 ft. high and well branched. At this time they are ready for field setting."

Growth.

"The root system of a two-year-old camphor tree consists of a taproot 1 in. in diameter at the top and about 3 to 5 ft. long. Up to this time the laterals are represented mainly by small fibres on the taproot. In transplanting under commercial conditions these fibres are killed and are not renewed as quickly as in some other trees."

Preparation of Land for Planting.

"The land should be well prepared by deep ploughing early in the fall and again worked just before the trees are set. It is desirable to lay off the rows in checks 6 by 15 ft., since this will facilitate later cultivation. The trees can be dug with a tree digger and should be cut back severely. All leaves and small twigs should be removed and the tree well headed back. The taproot should be cut back to 12 in. and all small laterals removed."

"The trees should be set at the same depth they were in the seed bed, and a small basin formed by the soil about them for the reception of water. One application of water should be given when the trees are set and one or two later on, as needed, if the rainfall is scanty. No growth will take place in the roots if dry soil is allowed to remain in contact with them, but too much water will cause the roots to sour and die."

Fertilizing and Cultivation.

"Cultivation should be thorough and frequent, and where it can be done, small crops, such as cotton, peas, and corn, should be grown between the rows for two or three years."

" At five or six years from the seed the trees should be 7 to 8 ft. high and very bushy. At this time the trees should be trimmed to shape them up into hedges and the first harvest should be secured."

Harvesting.

" On the Department's experimental plots the trees are planted in rows 15 ft. apart and 6 ft. apart in the row. They are grown to an A-shaped hedge 8 ft. high and 8 ft. wide at the base. By this method they are kept back to a convenient size for working and are not dwarfed sufficiently to injure the vigour of the tree. At six years from the seed the trees will form a solid hedge in each row and will be thick and bushy to the ground."

" Camphor is represented in the growing tissue by oil, which as the leaves mature is changed into camphor. Distillations made at different times during the growing season show a rapid gain in camphor content as the leaves approach maturity; also that it is highest during the dormant period."

Extract from article by B. J. Eaton in *Bulletin* 15, *Dept. Agriculture, F.M.S.*, pp. 10 and 11.

Propagation of Camphor.

" The seeds were soaked in lukewarm water for 24 hours before sowing. The soaking of the seed facilitates germination and separates the heavy seeds from the light. The heavy seeds sank to the bottom and these were sown by themselves in rows 3 in. apart each way and about $\frac{1}{4}$ of an inch below the surface. The light seeds were sown broadcast as only a few were expected to germinate."

" When the plants are from 10 to 12 in. high they may be transplanted, but, before doing so, it is advisable to cut off the tops of the seedlings and the ends of the roots. Transplanting should be done during the wet season and care taken to keep the young plants free from weeds as these retard their growth."

" Nursery Beds.—The beds should be well prepared by deep digging and the surface soil brought to a fine tilth. As the seeds take from two to six months to germinate, sand should be added in order to make the soil sufficiently porous to prevent the seeds rotting. It is essential to water and shade the seedlings carefully."

XV.—SPECIES PLACED BY SACCARDO IN THE GENUS PHOMA.

Part III.

W. B. Grove.

The present communication is a continuation of those which have appeared in the *Kew Bulletin* for 1919, pp. 177–201 and 425–445. The three parts together form a revision of most of those doubtful species of *Phoma*, of which specimens are preserved at Kew, and which were included in Saccardo's *Sylloge*, vol. III. But there are two limitations of its scope: (1) those previously treated of in my "British Species of *Phomopsis*" (*Kew Bulletin*, 1917, pp. 49–73) are not again referred to, and (2) none are mentioned except those of which good and, so far as possible, authentic examples were available. The absence of some which one might have expected to be included is due, in nearly every case, to the poverty of the specimens at hand, which might have led to erroneous conclusions. Moreover, the enquiry has not as yet been extended to those species which are contained in the later volumes of Saccardo, although some of them are equally in need of revision.

It is satisfactory that, by this means and by the labours of von Höhnel and other workers elsewhere, the genus *Phoma* has now been relieved of many species referred to it by the older mycologists, who regarded it as a convenient receptacle for doubtful forms. The genus *Macrophoma*, too, has almost disappeared.

It becomes plain, after examining a series of so-called species of *Phoma* like these, that there is a great possibility, and in many cases a certainty, of recognising the genus to which they really belong, even though the spores may be very young and so may not show the nominal generic character. The genera *Phoma*, *Phomopsis*, *Ascochyta*, *Diplodina*, *Diplodia*, etc. (not to mention *Sphaeropsis*, *Coniothyrium* and the *Leptostromaceae*) all have, even when imperfectly developed, certain distinctive traits which are suggestive, if not decisive. These traits should encourage a more persistent search, and, as many instances have shown, such a search will often be at length rewarded by the discovery of a few more fully-formed spores scattered among the rest. Apart from this, it is now beginning to be recognised that the nature of the pycnidium, and especially its texture, is in many cases as characteristic as any other feature of the Coelomycetes.

In what follows all figures, except where otherwise described, are × 600.

SPECIES TO BE TRANSFERRED TO PHOMOPSIS.

951. Phoma Yuccae, *Cooke.*

Phoma Yuccae, Cooke, in Grevill. 1878, vii. 32.

Phomopsis Yuccae, *Trav.* Flor. Ital. Crypt. Fung. ii, p. 221.

Phoma (*Diaporthe*) *gloriosa*, Sacc. in Mich. ii. 274 (1881); Syll. iii. 159.

Pycnidia gregarious, mainly on bleached spots which are surrounded by a dusky margin, elliptic, depressed, black, about 250 μ long, each often bordered by a brownish or blackish halo. Spores elliptic-fusoid, acute at both ends, occasionally biguttulate, 7·5–9 × 2–3 μ; sporophores subulate, curvulous, about 13–15 × 2–2·5 μ.

On flower-stalks of *Yucca filamentosa*, Aiken, South Carolina (Ravenel, nos. 2580 !, 2581 !).

Cooke's specimens are obviously the same species as that of Saccardo, which was on leaves of *Y. gloriosa*. They belong to *Diaporthe gloriosa*, Sacc. & Speg. (Syll. i. 660).

954. Phoma brunneola, *Sacc.*

Sphaeropsis brunneola, Berk. & Curt. N. Amer. Fung. in Grevill. 1874, iii. 1.

Phomopsis brunneola, *Grove.*

Pycnidia crowded, imperfect, oblong, often curved, covered by the discoloured epidermis, brownish-black, up to 500 μ long, somewhat hysterii-form, occasionally confluent. Spores exactly fusoid, very acute at both ends, or rarely broader towards one end, sometimes guttulate, 9–10 × 2–3 μ; sporophores subulate, straight, about as long as the spore.

On dead stems of *Smilax*. Specimens examined :—

Sphaeropsis brunneola, B. & C. on *S. rotundifolia*, New England, Sprague (Berk. Herb. no. 5269 !).

Phoma Smilacis, Gerard (*non* Boy. & Jacz.) on *Smilax*, Poughkeepsie.

Phoma Smilacis, on *Smilax*, Newfield, New Jersey (Ellis, no. 2914 !).

Most obviously a stage of a *Diaporthe*, but no *Diaporthe* on *Smilax* seems to be known. On the same stems, in Ellis, no. 2914, is the young state of *Diplodia smilacina*, Berk. (Sacc. Syll. iii. 370), with spores still uncoloured. One might easily suspect that *Phoma smilacina*, Sacc. Syll. iii. 160 (*Sphaeropsis smilacina*, Peck = *Macrophoma smilacina*, Berl. & Vogl. Syll. Addit. p. 314) is nothing else than the fusoid-spored state of this *Diplodia*, but no specimens of the "*Macrophoma*" have been seen.

961. Phoma Convallariae, *Westd.*

PHOMOPSIS CONVALLARIAE, *Grove.*

Pycnidia scattered, but often two or three surrounded by a thin brownish *Diaporthe*-like line, oblong, blackish, covered by the epidermis which at length splits above, mostly imperfect, floored by the usual soft brownish parenchymatous tissue. Spores elliptic-fusoid, usually acute, biguttulate, the guttules distant from the extremities, occasionally appearing 1–septate, 8–9 × 1·5–2·5 μ; sporophores linear-subulate, longer than the spore.

On stems of *Polygonatum multiflorum*, Namur (Westd. Herb. Crypt. Belg. no. 1136 ! *forma caulicola*). The pycnidium consists chiefly of the discoloured matrix.

Saccardo's subspecies *Phoma polygonatea* (Mich. ii. 617), at least as represented in Roum. Fung. Gall. Exs. no. 3674 !, does not seem to differ in any respect whatever. Evidently the pycnidium of a *Diaporthe*, and without doubt that of *D. pardalota* (Mont.) Nits. apud Fckl. (Sacc. Syll. i. 693).

SPECIES TO BE TRANSFERRED TO PLACOSPHAERIA.

935. Phoma maculata, *Sacc.*

Sphaeropsis maculata, Cooke & Hark. in Grevill. 1884, xii. 93.

PLACOSPHAERIA MACULATA, *Grove.*

Stroma widely effused, blackening the epidermis for several inches, whitish within; pycnidial chambers up to 1 mm. diam., convex, very prominent, oblong, then erumpent with a black rugulose disc which is at length pierced by 1–4 whitish spots where the spore-mass bursts through the surface. Spores elliptic-fusoid, pointed at one or both ends, granular or 1–guttulate, 8–10 × 3·5–5 μ; sporophores crowded, subulate, up to 15 μ long. (Fig. 1.)

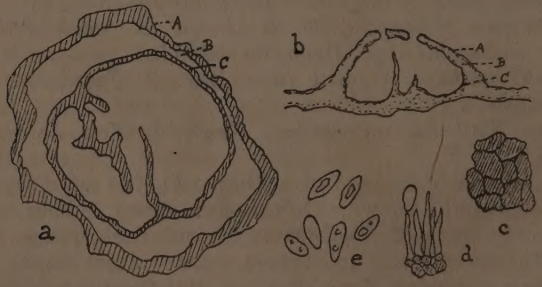

FIG. 1.—*Placosphaeria maculata; a*, horizontal section of pustule, showing the three layers A, B, and C, × 60; *b*, vertical section of pustule, showing two of the openings by which the spores emerge, × 30; *c*, cells of the outer wall, A; *d*, sporophores, *in situ*; *e*, spores.

On fading leaves, petioles, and stems of Palms, California (Cooke, Herb. no. 2546 !); on fading leaves of *Chamaerops excelsa*, Portugal, Moller (Roum. Fung. Sel. Exs. no. 4464 !).

This is a *Placosphaeria*, for in *Dothiorella* there is no outward black layer of epidermis. The external appearance resembles that of *Placosphaeria* (*Rhytisma*) *Urticae*, Sacc. = *Melasmia Urticae*, Grove in Journ. Bot. 1918, p. 319, but the pustules are much larger. Each is imperfectly divided into several chambers, which are filled with a colourless mass of spores. The outer wall of the pustule is many cells thick, the outer layer and the inmost of which are dark-brown (cells 5–6 μ diam.), the middle part being paler. The three layers A, B, and C, are shown in vertical and horizontal section in fig. 1, *a* and *b*; A = the altered black epidermis, B = the less altered cortex, partly of fungous cells, C = the inner wall from which the sporophores spring. But C shades into B, there is no abrupt transition; at the base only C is present. The part of the matrix occupied by the fungus forms a large black patch extending for a considerable distance; the older pycnidia fall out of this, and leave pale roundish pits or scrobiculations.

SPECIES TO BE TRANSFERRED TO DIPLODIEAE.

908. Phoma malorum, *Sacc.*

Sphaeropsis malorum, Berk. Outl., p. 316 (1860).

Sphaeropsis malorum, Peck, Ann. Rep. 1881, xxxiv. 36, pl. 4, figs. 16–21. Sacc. Syll. iii. 294.

Macrophoma malorum, Berl. & Vogl. Syll. Addit. p. 310.

Diplodia Pseudodiplodia, Fckl. Symb. Myc. p. 393.

Diplodia malorum, Fckl. Symb. Myc. p. 395.

Berkeley's original specimens were examined; as is well-known, they are merely young *D. malorum*, Fckl. They yielded abundant colourless spores, and many tinged with dilute brown ("sporulis chlorino-hyalinis"), but also not a few which were decidedly of a *Diplodia* brown, though none were found with a septum. They do not differ in any respect from those of Peck, and correspond in all their characters with the ordinary young *Diplodia*. It should be noticed that *D. malorum*, Fckl. is merely a synonym (two pages later) of *D. Pseudodiplodia*, Fckl., but the former name should be preferred, since the latter is inappropriate and inconsistent—a true *Diplodia* cannot be a "false-*Diplodia*."

910. Phoma samaricola, *Sacc.*

Macrophoma samaricola, Berl. & Vogl. Syll. Addit. p. 310.

Sphaeropsis samarorum, Mont. cent. vi, no. 89 !

? Diplodia atrata, Sacc. Syll. iii. 331.

Pycnidia subgregarious, lens-shaped, black, 80–100 μ diam., covered by the epidermis except for the ostiole; texture olive-brown, rather thin, parenchymatous. Spores oblong-fusoid,

rounded at the ends, straight in front view, narrower and curved in profile, colourless, granular within, occasionally biguttulate, 16–20 × 4·5 — 5·5 μ; sporophores not seen. (Fig. 2*a*.)

On the samarae of *Acer Pseudoplatanus*, *A. Negundo*, on the pericarp, not on the wings. The figure is taken from spores of Montagne's own specimen in Herb. Berk., named in Montagne's handwriting "*Sphaeropsis samarorum*, Mont."

These fusoid spores remind one of the others like *Phoma fusigera*, *P. fusispora*, *P. Ricini* (*ante*, 1919, pp. 191–3, 437), so that, except for the thin pycnidial wall, one could at once accept this as a mere young state of a *Diplodia*. If so, it belongs to *Diplodia atrata*, Sacc., which occurs on bark of *Acer Pseudoplatanus* and *A. Negundo*, and has equally inconspicuous sporophores, but is thick-walled. It may be taken as a certainty that the idea, prevalent up to Saccardo's time, that the fungi found upon twigs or branches must be different from those found upon the leaves, fruits, and other parts of the same plants, has little or no foundation; but it is true that those forms which occur on the less bulky structures, like samarae, are slighter in texture than those on the thicker parts.

As an instance of what could be done by those who followed the old tradition, there is in the Herbarium under the name *Phoma samaricola* a specimen issued by Fuckel ("*Phoma ellipticum*, Fckl." Fung. Rhen. no. 2128 !), on rotting samarae of *Acer platanoides*, which is obviously a *Phomopsis*, and probably = *Phomopsis platanoidis*, Died., probably also *Phoma Aceris-Negundinis*, Arc., is another synonym of the same species.

Thus there can be found on samarae of *Acer* at least three fungi, similar at a cursory glance, but differing considerably in their spores, (1) *Phomopsis platanoidis*, Died., (2) *Phoma samararum*, Desm., and (3) *Macrophoma samaricola*, B. & V., of which (1) belongs to a *Diaporthe*, (2) to a *Pleospora*, and (3) probably to a *Diplodia* and perhaps ultimately to a *Botryosphaeria*.

FIG. 2.—*a*, "*Sphaeropsis samarorum*, Mont.," spores from Montagne's specimen in Herb. Berk.; *b*, "*Sphaeropsis Palmarum*, Cooke," spores from Cooke's specimen; *c*, "*Sphaeropsis Pandani*, Lév.," spores from the specimens sent by Léveillé to Berkeley.

933. Phoma Palmarum, *Sacc.*

Sphaeropsis palmarum, Cooke, in Grevill. 1877, v. 101, pl. 86, f. 1 (on petioles and midribs of *Cocos nucifera*).

Macrophoma Palmarum, Berl. & Vogl. Syll. Addit. p. 311.
Diplodia epicocos, Cooke, in Grevill. *ibid.* p. 102, pl. 86, f. 2.
D. palmicola, Thüm. Sacc. Syll. iii. 372.

Cooke's specimens of the *Sphaeropsis* are evidently a young *Diplodia*, recognisable as such at the first view of the granular spores: although all the spores seen were eseptate, many of them had a brownish wall. (Fig. 2*b*.) The best developed pycnidia (even though the spores still remained quite colourless) were exactly like those of *D. epicocos*, and the spores of the latter (in Cooke's own specimens) were often mixed in the same pycnidium with colourless ones like those of the "*Phoma*." *D. palmicola*, Thüm. (Fung. Austr. no. 59 !), on epicarp of *Cocos*, does not differ in any respect except words. Cooke's figure (pl. 86, f. 2) is misleading; the *Diplodia* spores are rarely constricted, and have the septum broad and dark.

939. Phoma Pandani, *Sacc.*

Sphaeropsis Pandani, Lév. in Ann. Sci. Nat. 1846, v. 293.
Macrophoma Pandani, Berl. & Vogl. Syll. Addit. p. 310, and x. 197.
? Diplodia Pandani, *Tassi*; *see* Sacc. Syll. xvi. 923.

This is another instance of what has been noted so many times. The older observers of these fungi (it was the custom of their age) paid no attention to the changes which spores undergo during their development. On examining the authentic specimens sent by Léveillé to Berkeley, it is seen that the pycnidia contain numerous large hyaline spores, but mixed with them are a small number of brown spores, mostly uniseptate, with all conceivable intermediate stages. (Fig. 2*c*.) Evidently it is a *Diplodia* or a *Botryodiplodia* (the latter is partly, if not entirely, merely a state of the former); but it does not seem to agree entirely with *Diplodia Pandani*, Tassi (Sacc. Syll. xvi. 923), "on dry fruits of *Pandanus utilis*, Madagascar." Nevertheless it may be that species.

Léveillé's original account (*l.c.*) is very accurate, and need not be repeated here: the spores are elliptic-oblong or obovoid, at first quite colourless and very thin-walled, at length dark-brown and 1-septate, 23–25 × 14–15 μ. The pycnidia are, as Léveillé states, distinct but "très rapprochés," each enclosed in the ruptured epidermis and surrounded by a thin layer of brown creeping branched fibres. Léveillé's specimens have no locality affixed, but were apparently found on dried fruits of *Pandanus*, preserved in the herbarium of the Paris museum.

946. Phoma elongata, *Sacc.*

Sphaeropsis elongata, Berk. & Curt. in Grevill. 1874, ii. 181.
Macrophoma elongata, Berl. & Vogl. Syll. Addit. p. 314.

Pycnidia gregarious, globose-depressed, 150–250 μ diam., black, covered by the epidermis, then erumpent by the upper

half, pierced by a pore, surrounded by dark-brown creeping hyphae, at length collapsed; texture thick, opaque, dark-brown. Spores elongate-fusoid, rounded at both ends, granular, colourless, 20–25 × 4·5–5·5 μ; sporophores oblong, thick, more or less curved, blunt at apex, colourless, 15–16 × 3–4 μ. (Fig. 3*a*.)

On stems of *Gladiolus*, Alabama, Peters (Herb. Berk. no. 5231 !) *See also* the next species.

In some of the larger pycnidia actual *Diplodia*-spores were to be seen, translucent, pale-brown, somewhat fusoid, 18–20 × 5–6 μ, but no intermediate stages could be detected. Nevertheless, it is impossible to come to any other conclusion than that the two kinds of spore belong to the same fungus: the cases now established of such a connection are too numerous to permit of any doubt. So far, however, no *Diplodia* on *Gladiolus* seems to have been described. The appropriate name for this would be *Diplodia elongata*; the species of the genus, which have spores that are fusoid when young, should form a distinct section, the Fusisporae. *See* nos. 910 and 994.

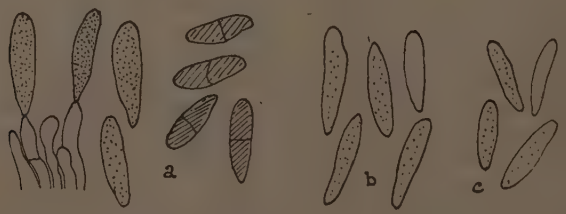

Fig. 3.—*a*, "*Sphaeropsis elongata*, B. & C.," spores from the specimen on *Gladiolus* (Herb. Berk. no. 5231), young spores on the left, mature on the right; *b*, "*Sphaeropsis lanceolata*, Cooke & Ell.," spores from Ravenel, no. 3106, on *Gladiolus*; *c*, the same, from Ellis, no. 3011, on *Asparagus*.

967. Phoma lanceolata, *Sacc.*

Sphaeropsis lanceolata, Cooke & Ell. in Grevill. 1878, vii. 38.
Macrophoma lanceolata, Berl. & Vogl. Syll. Addit. p. 314.
? Diplodia Georginae, Lév. in Ann. Sci. Nat. 1846, p. 292.

Pycnidia crowded or gregarious, black, 200–300 μ diam. or even more, rather prominent, covered, then erumpent; texture very thick and dark, parenchymatous, consisting of several layers. Spores lanceolate-fusoid, tapering (but still obtuse) at both ends, very granular within, 23–25 × 4·5–5 μ; sporophores slender, linear, about as long or longer. (Fig. 3, *b* and *c*.)

On dead stems of *Gladiolus*, South Carolina (Ravenel, no. 3106 !); on *Dahlia* (*ibid.* no. 3107 !); also on *Gladiolus* (Cooke and Rav. Fung. Amer. exs. no. 544 !); on *Asparagus*, Newfield (Ellis, Fung. N. Amer. no. 3011 !).

On the same sheet, under the same name, is a fungus on Nettle stem (Ellis, Fung. N. Amer. no. 1229 !) which is chiefly *Didymella superflua*, Sacc., with its associated *Phoma*, but no

Phoma lanceolata. But the specimens on *Gladiolus*, *Dahlia*, and *Asparagus*, are all very much alike and belong to the same group as the *Phoma fusigera* already mentioned (*see* under no. 910). They probably belong to *Diplodiae* such as *D. Georginae*, Lév., but what they really mean cannot be decided now. Cooke gives the spores on *Asparagus* as $30 \times 7\ \mu$, but none so large were seen; they were mostly even shorter than on *Gladiolus*.

972. Phoma Musae, *Sacc.*

Sphaeropsis? *Musarum*, Cooke, in Grevill. 1880, viii. 93.

Macrophoma Musae, Berl. & Vogl. Syll. Addit. p. 311.

? Diplodia Radula, B. & Br. Fung. Ceyl. no. 785. Sacc. Syll. iii. 371.

The following specimens were examined :—

"*Sphaeropsis Musarum*," Cooke, Herb. no. 230 !, Belgaum, India, coll. Hobson. (Fig. 4*a*.)

"*Macrophoma Musae*," Sydow, Fung. Exot. Exs. no. 189 !, Manilla, coll. Graff. (Fig. 4*b*.)

(Both of these are on dead leaves of *Musa paradisiaca*, but it is also recorded by Petch on fruits of Plantain, Peradeniya).

"Diplodia Radula," Herb. Berk.n o. 305 !, on leaves of *Musaceae*, Ceylon. (Fig. 4*c*.)

Cooke's specimens (no. 230) have the pycnidia in dense round clusters : they suggest at the first glance a *Botryodiplodia*, for under the microscope all the characters of a young *Diplodia* are present, except that there were no sporophores visible. Now Berkeley described his *Diplodia Radula* on leaves of Musaceae, but his specimens (no. 305) show no signs of having the pycnidia conglomerated; nevertheless the gap is bridged over by Sydow's specimens (no. 189), for in them there are numerous single pycnidia, and also they show many clusters exactly like those of Cooke's no. 230.

It is therefore suggested that *Macrophoma Musae* = *Diplodia Radula*, B. & Br., although with reservation. The spores of both are all but the same, for most of the spores of Berkeley's specimens of his *Diplodia* are colourless, though granular, and are nearly of the same size and appearance : only a few of the older pycnidia were exuding long strings of brown 1–septate spores. Sydow's spores are smaller than those of Cooke. In all these specimens, including *D. Radula*, no sporophores are now discernible; this is known also to be the case in *D. atrata*.— In Berkeley's specimens (no. 305) long slender gelatinous paraphyses occur similar to those which are found in some pycnidia of *Botryodiplodia Theobromae*, Pat., and the pycnidial walls show traces of the same violet- or purple-brown tinge as it possesses. Is it possible that the *Diplodia* on *Musa* is only a biologic form of *B. Theobromae*? *Musa* is not mentioned among the hosts of that species by Petch (*see* the next no.

Phoma Sacchari), but this suggestion deserves consideration by tropical mycologists.

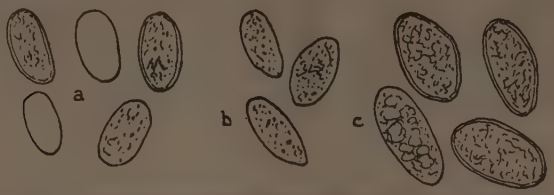

FIG. 4.—*a*, "*Sphaeropsis Musarum*, Cooke," no. 230; *b*, "*Macrophoma Musae*, B. & V.," from Sydow, no. 189; *c*, "*Diplodia Radula*, B. & Br.," from Berk., no. 305 (young colourless spores, among the coloured ones).

994. Phoma Sacchari, *Sacc.*

Sphaeropsis Sacchari, Cooke, in Grevill. 1883, xii. 23.

Macrophoma Sacchari, Berl. & Vogl. Syll. Addit. p. 311.

M. vestita, Prill. & Delacr. in Bull. Soc. Myc. Fr. 1894, p. 165, pl. 6, f. C. Sacc. Syll. xi. 496.

BOTRYODIPLODIA THEOBROMAE, *Pat.* in Bull. Soc. Myc. Fr. 1892, p. 136. Sacc. Syll. xi. 522.

The "*Macrophoma*" is obviously an immature state of *Botryodiplodia Theobromae* (which is known to occur on *Saccharum*), and is plainly the same as *M. vestita*, except that the clothing of hairs is wanting and that the spores are less ovoid and more lanceolate. Cooke's specimens examined (Ravenel, no. 3173 ! = Cooke & Rav. Fung. Amer. Exs. no. 693 !, on Sugar-cane, Georgia) have exactly the pycnidial texture of the *Botryodiplodia*, even including the faint tinge of purple, and after a long search numerous brown, but eseptate, spores were at last discovered in some of the pycnidia: they may be called f. *Sacchari*.

With regard to the hairs of *M. vestita* the epoch-making work of Petch on *Lasiodiplodia* (Ann. Roy. Bot. Gard. Peraden. 1910, iv. 445) is conclusive; the hairs are produced on the outside of the fungus when it is growing in a damp atmosphere (*M. vestita* grew on *roots* of *Theobroma*), but on the dry stems they would be altogether wanting. As regards the lanceolate spores, this is evidently another case comparable to those mentioned before under *P. fusigera* (*see* no. 910); what the exact meaning of these lanceolate or fusoid spores may be has yet to be determined, but there can be no doubt that in certain circumstances a *Diplodia* or a *Botryodiplodia* produces them.

Thus four or five fresh names (besides the round dozen summed up by Petch) become mere synonyms of *Botryodiplodia Theobromae*, Pat. Anyone who has access to a sufficient number of original (type) specimens could carry on this process to a considerable extent, apart, that is to say, from biological differences. These latter, however, as usually stated, are largely illusive; for they are dependent to a degree which they do not yet admit

on the manipulative methods of the experimenters, as Eriksson has quite unwittingly demonstrated again and again. In this way the overwhelming number of "species" now described can be slowly reduced to a more manageable compass. But this must not be done from mere book descriptions.

If, in addition, investigators would consent to adopt the simple plan of ranging "biologic" forms or races under a common head without confusing the issue by adopting the common title as a name also of one of the subordinate forms, the vast mass of names would be brought more and more within the limits of comprehension.

SPECIES TO BE TRANSFERRED TO HYALODIDYMAE.

947. Phoma Gladioli, *Sacc.*

Sphaeropsis Gladioli, Cooke, in Grevill. 1883, xii. 23.

Macrophoma Gladioli, Berl. & Vogl. Syll. Addit. p. 311.

Ascochyta Gladioli, *Trav. & Spess.* in Bolet. Soc. Brot. 1910, xxv. 180, pl. 3, f. 20. Sacc. Syll. xxii. 1027.

? *Phoma conimbricensis*, Trav. & Spess. *ibid.* p. 175, pl. 2, f. 8.

Spots often roundish, about 4–5 mm. diam., bleached or pallid. Pycnidia grouped, often in circles, globose-depressed, 130–150 μ diam., blackish, covered by the epidermis, then erumpent, pierced at the apex by a pore; texture thin, plectenchymatous, honey-coloured or darker. Spores cylindric-oblong, at length thinly 1-septate, not or faintly constricted, often slightly curved, granular within, colourless, 15–18 $\times$ 4·5–6 μ. (Fig. 5*a*.)

On leaves of *Gladiolus*, South Carolina (Ravenel, no. 2956 !).

The greater part of the spores in Ravenel's specimens are eseptate, but there is noticeable a slight constriction and bending of many spores, which serves as an omen of the true state of things, and here, as usual in such cases, persistent search reveals a number of them which are 1-septate. Moreover the texture of the pycnidium is that characteristic of *Ascochyta*. Cooke wrongly gives the size of the spores as 20 $\times$ 5 μ. There can be no doubt that *Phoma Gladioli*, (Cke.) Sacc. is the same fungus as *Ascochyta Gladioli*, Trav. & Spess., although those authors give the size of their spores as being 12–15 $\times$ 2·5–3 μ. They also record (*l.c.*) a fungus to which they give the name *Phoma conimbricensis*, as accompanying the *Ascochyta* on scapes of *Gladiolus cardinalis* in the Botanic Gardens at Coimbra, Portugal. A comparison of the descriptions, and a knowledge of what is now known to take place in many other cases, enables one to presume with certainty that *Phoma conimbricensis* is merely the young state of the *Ascochyta*. It is time that systematists (and pathologists also) began to admit more readily that such a sequence of states is a quite common phenomenon. When once its existence is

recognised, the proofs of its occurrenee are easily observed, and many superfluous synonyms might be thereby avoided.

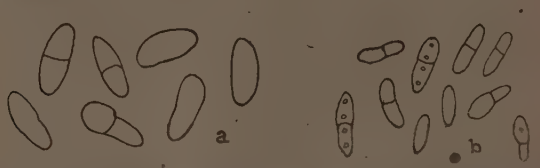

Fig. 5.—*a*, "*Sphaeropsis Gladioli*, Cooke," spores from Ravenel, no. 2956; *b*, "*Sphaeropsis epitricha*, B. & Br.," spores from Broome's specimen.

1005. Phoma epitricha, *Sacc.*

Sphaeropsis epitricha, B. & Br. in Ann. Nat. Hist. 1850, v. 375.

Ascochyta Equiseti, *Grove*, in Journ. Bot. 1918, p. 315 (var.).

Phoma Equiseti, Desm. Exs. no. 183. Sacc. Syll. iii. 168; x. 187. Allesch. vi. 341.

Sphaeria Equiseti, Sacc. Syll. ii. 442.

? *Diplodina Equiseti*, Sacc. in Annal. Mycol. 1905, p. 233; Syll. xviii. 355.

? *Stagonospora Equiseti*, Fautr. in Rev. Mycol. 1890, p. 124; Sacc. Syll. x. 337.

The specimens to which Berkeley gave the name *Sphaeropsis epitricha* were found on dead stems of *Equisetum palustre*, in Wiltshire, by Broome. Berkeley's description of the "subiculum" is a little misleading. The pycnidia are surrounded by numerous creeping branched, somewhat torulose, brown hyphae, about 4 μ broad. It is this which causes the "cinereous spot." The pycnidia are about 160 μ wide, thick-walled, of a dark-brown texture, prominent and at length piercing the epidermis by a rather wide pore. Some of the numerous spores look at first sight like what Berkeley described, but, on adding dilute potash (which presumably restores them to their pristine shape and size), they assume the appearance of *Ascochyta* or *Diplodina* spores, 10–16 × 3·5–4·5 μ, oblong, obtuse at the ends, often slightly bent, with a few guttules and often a faint septum, quite colourless, cells occasionally unequal. (Fig. 5*b*.)

There cannot be the slightest doubt that this species is in the state which is usually called *Diplodina*, taking that genus to differ from *Ascochyta* in the nature of its pycnidial wall (thick and dark, not thin and pale). At the same time it seems probable that it is only a more fully developed state of *Ascochyta Equiseti*, mihi. And as I have proved that that is an advanced state of what has long been called *Phoma Equiseti*, the three are probably synonymous. The spores of the "*Phoma*" can be traced *in the same pycnidium* from ovoid, eseptate, 6–7·5 × 3 μ, up to oblong, 1-septate, 10·5–12 × 3–3·5 μ; those of *Diplodina Equiseti*, Sacc., are given as cylindrical, 16–19 × 4–4·5 μ, at

length minutely 4-guttulate; moreover Diedicke and others have found the *Phoma* and the *Diplodina* "growing in company." Those of the "*Sphaeropsis*" just fill up the gap. Finally there does not seem to be any reason why *Stagonospora Equiseti*, Fautr., should not be considered a still further development of the same fungus, with cylindrical 3-septate spores, 20–25 × 4–5 μ. They all occur on the same host, stems of *Equisetum* (chiefly *E. limosum*). It may be mentioned, finally, that *Phoma Equiseti*, Lév. (Ann. Sci. Nat. 1846, p. 282) differs from *P. Equiseti*, Desm. merely in having spores of a more ellipsoid form, but all the forms from round to oblong may easily be found in the same pycnidium.

SPECIES TO BE TRANSFERRED TO LEPTOSTROMACEAE.

987. Phoma donacella, *Sacc.*

Coniothyrium donacinum, Thüm. Contr. Myc. Lusit. no. 340.
Leptostroma donacinum, Sacc. Syll. iii. 642.
L. Donacis, Sacc. in Mich. ii. 352.

The specimen examined was one of Thümen's own, on dead culms of *Arundo Donax*, Coimbra (Flora lusitanica, legit Moller). It is obviously a *Leptostroma*, and there is no difference between it and *L. donacinum*, Sacc. It should therefore stand as L. donacinum (Thüm.), Sacc.; moreover it is the same as *L. Donacis*, Sacc., in Mich. ii. 352.

Accompanying it and intermingled with it on Thümen's specimens is *Gloniella microtheca*, Sacc. & Speg. (Syll. ii. 768), of which it is doubtless the pycnidial stage. (Fig. 6*a*.) In this connection it may be added that the "aparaphysatis (?)" of Saccardo in the description of this species of Pyrenomycete (*l.c.*) can have the "(?)" deleted: there are no paraphyses. The ascophores are on bleached patches, and the spermogones chiefly on the surrounding unbleached parts. The spermatia are subcylindrical, not "ellipsoid," often curved as in *Cytospora*, and measure about 4 × 1 μ. The connection between the spermogone and the ascophore is precisely similar to that between *Leptothyrium Hederae*, Starb. and *Hypoderma Hederae*, De Not., and between *Leptostroma virgultorum*, Sacc. and *Hypoderma virgultorum*, DC. *See* Journ. Bot. 1918, p. 319.

990. Phoma viridispora, *Cooke.*

Pirostoma viridisporum, *Grove.*

Pycnidia roundish or (when mature) oblong, up to 1 mm. long, more or less aggregated, sometimes in longitudinal series, black, covered only by the cuticle, opening by a pore; texture of loose round dark cells, not compacted into a pseudoparenchyma. Spores fusoid, acute at both ends, eguttulate, greenish-olive, 9–11 × 2·5–3 μ; sporophores linear, as long as the spore. (Fig. 6*b*.)

On dry dead leaves of *Phormium tenax*, New Zealand (Herb. Cooke, *T. Kirk*, nos. 206 ! and 328 !).

The mycelium begins to grow in the epidermal cells which it destroys; the cuticle is at first raised in the centre, and forms a white spot in a black disc; afterwards it is burst open about the middle to form an irregular pore.

This fungus presents a considerable resemblance to *Pirostoma Farnetianum* Pollacci, on *Pandanus*. *See* Pollacci, in Atti Ist. Bot. Pavia, 1897, v. 195, pl. 7, figs. 11, 15, 16, and Sacc. Syll. xiv. 996.

FIG. 6.—*a*, Asci and spore of *Gloniella microtheca*, from Thümen's specimen on *Arundo Donax*; *b*, spores of *Pirostoma viridisporum*, from Kirk, no. 206; *c*, *Eriothyrium pelliculosum*, (1) pycnidium, showing margin and pore, × 180; (2) cells of margin; (3) spores and sporophores.

991. Phoma Phormii, *Sacc.*

Coniothyrium Phormium,* Cooke, in Grevill. 1879, vii. 96.

LEPTOTHYRIUM PHORMII, *Grove*.

Pycnidia densely aggregated, 200–300 μ diam., black, lens-shaped, subcuticular, raising the cuticle in a little ridge which at length splits away in various forms, mouthless, but the upper part at length disappearing. Spores very numerous, embedded in mucus, singly colourless, hardly coloured in mass, ovoid in face-view, oblong in profile, often more or less flattened, faintly guttulate, 3–4 × 1–2 μ; no sporophores visible. (Fig. 7.)

On dead leaves of *Phormium tenax*, in the Botanic Gardens, Brussels (specimens of *Phormium* stated to be in the University Herbarium, Edinburgh), Cooke, Herb. no. 71 !

This fungus resembles no. 990 (*Pirostoma viridisporum*) so closely in external appearance that one is tempted to regard it as an early stage of that species; the fabric of the pycnidium and its mode of origin are the same in both cases, but the obstacle to such a belief is that no intermediate forms of spores could be detected. At any rate it could be called a "forerunner," standing to the *Pirostoma* exactly as some species of *Phyllosticta* stand to *Phleospora* (*see* Journ. Bot. 1918, p. 206). The mycelium originates in the epidermal cells, fills them completely and destroys them; then, as the pycnidium grows, the cuticle is pushed up and cracked away from the subjacent layers of cells. The texture of the several-layered pycnidial wall is of loose small roundish dark-purplish-brown subopaque cells, very variable

* This should be taken as if printed "*Phormii*."

(5–10 μ) in diameter; these are not strongly coherent as in a typical *Phoma* pycnidium, but form a thickish irregular crumbly stratum, surrounding the spore-cavity on all sides, but thicker above and below than round the margin. They break apart easily on pressure, and behave much like the pycnidium of a *Phomopsis*, which latter, indeed, except for the fact that it arises beneath the epidermis, is more closely allied to the *Leptostromaceae* than to the *Sphaeropsidaceae*, though not exactly of either type.

Whether it is right to place the present species in *Leptothyrium* or in one of its allies cannot be decided until someone revises the *Leptostromaceae* according to modern notions, but it certainly falls within Saccardo's definition of the former and belongs to Diedicke's §D.

An imperfect state of the same fungus, labelled in Cooke's Herbarium "*Phoma phormicola*, Cooke," on dead *Phormium* (Kirk, no. 134 !), from Stewart Island, New Zealand, is in the same cover: but another small specimen (Kirk, no. 77 !) from New Zealand, also on dead *Phormium*, has a true pycnidium and *Cytospora*-like spores about 5 × 1 μ—this is labelled in Cooke's handwriting "*Phoma Phormii*, Cooke," and as it has no stroma, it may belong to that genus, but it is not = *Phoma Phormii*, Sacc.

FIG. 7.—*Leptothyrium Phormii*, vertical section through a pycnidium, *in situ*, × 210; the cells marked *x* are the stone-cells of the mesophyll; below are shown five spores, × 600.

Strangely enough, I have lately received from Mr. D. A. Boyd some excellent specimens of this *Leptothyrium*, on decaying leaves of *Phormium tenax*, from Hunterston, Ayrshire, and Stranraer, Wigtonshire. Possibly the fungus accompanies the host wherever it is cultivated, just as *Coniothyrium concentricum* accompanies the species of *Yucca*; if so, it will be found in the plantations of *Phormium* which are beginning to be made in Ireland, but as it is only a saprophyte it may be of no economic importance.

The Scotch specimens agree perfectly as regards the pycnidia and spores with those from Brussels, but a curious feature seen in them is that some parts of the cuticle are broadly dyed of a pinkish-red colour. On searching for the cause of this, it was found that accompanying the *Leptothyrium* was a *Leptosphaeria*, the perithecia of which are larger and thicker than the pycnidia of the *Leptothyrium*, and are surrounded about the base by numerous creeping hyphal threads of a deep purplish red.

It would seem, on examination, that the colour is dissolved out of the hyphae, ? by rain, and tinges the cuticular layer just as "Soudan red" will do.

The description of the *Leptosphaeria* is as follows :—

LEPTOSPHAERIA PHORMII, sp. nov.

Perithecia circa 400 μ diam., lentiformia, atra, opaca, tecta, dein vertice erumpentia, basi hyphis purpurascentibus obsita; contextu crasso, parenchymatico, subpurpureo-brunneo. Asci elliptico-oblongi, apice rotundati, tenuissime tunicati, breviter pedicellati, 8-spori, paraphysibus parcis vel nullis cincti; sporidia biseriata, elliptica, 3-septata, ad septa subconstricta, 18–20 × 7–7·5 μ, loculis dilute fuscidulis.

In foliis emortuis *Phormii*, in Scotia (Boyd).

992. Phoma pelliculosa, *B. & Br.*

This is a curious species, belonging to the section Pycnothyrieae of the *Leptostromaceae*, and if a slight emendation be made it can be placed in Spegazzini's genus *Eriothyrium* (Sacc. Syll. x. 418). The only other known species of *Eriothyrium* (*E. dubiosum*, Speg. *l.c.*) differs in its fuliginous subiculum and its more ovoid spores. Whether the two are really congeneric or not, cannot be decided until more allied species are found.

ERIOTHYRIUM, Speg. emend.

Pycnidia minute, scutato-dimidiate, adnate, ostiolate, surrounded by an effused very thin smoky or fuscous-pallid subiculum. Spores hyaline, continuous, oblong or ovoid.

ERIOTHYRIUM PELLICULOSUM, *Grove.*

Pycnidia black, 50–100 μ diam., crowded, round, shield-shaped, dimidiate, applanato-convex, pierced by a wide central round or irregular impressed pore; texture of dark-brown cells, about 2–3 μ diam., distinctly radiating, especially at the margin. Spores narrow-oblong, straight or curvulous, about 3 × 1 μ; sporophores rod-shaped, up to three times as long, springing from the underside of the shield. (Fig. 6*c*.)

Under the cuticle of Bamboo stems, Peradeniya (B. & Br. Ceylon Fungi, no. 438 !).

The pycnidia have a similar texture to that of *Actinothecium caricicolum*, Ces. (Sacc. Syll. iii. 639). They consist of a thickish shield-shaped brown layer, lying on the destroyed epidermis, and formed of linear or ellipsoid cells distinctly radiating round the margin; this margin is, when untouched, continuous as in the simpler specimens of the *Actinothecium*, or as in *Actinothyrium*, *i.e.*, except for single projecting cells, it is not deeply indented, yet on the slightest pressure the shield splits into radiating sectors, though none of them were ever so deeply partite as the extreme forms in Cesati's figures in Hedwigia, i. 80, pl. 11, f. 3.

The pycnidia are immersed in, and at first covered by, a thin membranaceous subiculum which appears to be composed of densely interwoven pallid hyphae, adherent to the cuticle; at length the vertex of each shield emerges from the weft, splitting the cuticle and opening by a pore which gradually grows wider; ultimately the shield falls away entirely, leaving a little pit. The cells of the subiculum are thin-walled, very indistinct and tightly packed, forming a pseudoparenchyma, but occasionally the course of the separate radiating hyphae can be discerned, and in that case it reminds one of the thin peridium of the uredo-sori of a *Thecopsora*.

The mycelium appears to arise in the epidermal cells, which it ultimately destroys, leaving a layer of hyphae lying on the sclerenchymatous zone which underlies the epidermis, and separating easily therefrom. These hyphae leave the impression of the shape of their cells in the cuticle, and so that part of the cuticle beneath which the pycnidia are formed is seen to be "punctulate" with little roundish depressions. This gives it an appearance which makes a "contextus subanhistus punctulatus (non vere cellulosus)" like that which Saccardo falsely (in most cases at least) ascribes to the pycnidia of *Sacidium* (Syll. iii. 625). In all the cases that I have seen such a punctulate anhistous pycnidium is nothing but the darkened cuticle of the host, marked with the impressions of the subjacent fungous cells. This phenomenon can, of course, arise only where the fungous tissue is covered by the *cuticle* alone, as is usual in the *Leptostromaceae*. It may be noticed in passing, however, that some species of *Gloeosporium*, e.g. *G. Potentillae*, Oud. = *Marssonia Potentillae*, Fisch., have the pustules also covered only by the cuticle, so that this peculiarity is not confined to the *Leptostromaceae* and the *Melampsoraceae*.

995. Phoma Ammophilae, *Sacc.*

Perisporium Ammophilae, Dur. & Mont. Flor. Algér. p. 564.

The "*Perisporium*" is thus described by its authors:—

"P. emergens globosum minutissimum myriadeum atrum maculae cinereae insidens, sporidiis . . ." They add "Perithecia confertissima, 40–70 μ diam."

Jaap found on *Ammophila arenaria* in Schleswig-Holstein a fungus which he put down to this species; it had variable biguttulate spores about $5 \times 3\,\mu$, and caespitose sporophores about $25 \times 3\,\mu$. In this sense possibly *P. Ammophilae* (D. & M.) Sacc. may be upheld.

The specimens under this name, however, available for examination (Roum. Fung. Gall. Exs. no. 3562 !), on leaves and glumes of *A. arenaria*, from Algeria, showed two fungi. One of these is = *Sphaeropsis lugubris*, Bomm. Rouss. & Sacc. (Syll. x. 258); the spots on which it is seated answer to the description of Durieu and Montagne fairly well, but it cannot be their species because the pycnidia are larger and not crowded. The other,

not seated on grey spots, is = *Phoma nitida*, Rob. (*see* next species, no. 997, and fig. 8*b*), and if not identical with that of Jaap, of which no specimens have been seen, seems at any rate to be very similar to it; in that case they probably both belong to *Leptothyrium*. The question cannot be decided until better specimens are available.

997. Phoma nitida, *Rob.*

Leptothyrium nitidum, *Grove.*

The specimen examined (Desm. Crypt. Fr. sér. 2, no. 355 !), on dry stems of *Calamagrostis arenaria*, has the spores of a *Phoma*, but as the pycnidium is very incomplete it should be placed in another genus. It has a thin dark pycnidial layer above, and a much softer and paler stratum below. Spores ovoid or ellipsoid, vacuolate in the middle, *i.e.*, with the protoplasm retracted to each extremity, 3–5 × 2–2·5 μ; sporophores crowded, subulate, very variable in length, averaging 10–12 μ long, often swollen below, *i.e.*, more or less ampulliform. (Fig. 8*b*.)

Each pycnidium forms a little convex, almost hemispherical, brownish-black and shining pustule, surrounded by a narrow halo which shades off gradually and is formed by brown hyphae. It is not a *Phomopsis*, and certainly not a *Phoma*, though its pycnidium seems to resemble that of *Phoma Cookei*, Pirotta = *P. Vitis*, Cooke, *non* Bon. Probably both these should be placed in the *Leptostromaceae*.

Species probably to be left in Phoma.

915. Phoma Siliquastrum, *Desm.*

Desmazières' own specimen (Crypt. Fr. sér. 1, no. 1874 ! possesses subcylindrical spores very similar to those of *Phoma oleracea*, Sacc., but the pycnidia are smaller and less black, approaching more to the texture of a *Phyllosticta*. They are intermediate between those of *P. oleracea* and those of *P. exigua*, Desm. on *Linum*, but do not exactly agree with either. The spores measure about 5 × 1 μ or less; the pycnidia occupy small olivaceous-brown patches, such as neither of the other two mentioned possesses.

On account of the spores they could not be referred to *Phoma nebulosa* (Pers.) Mont., as the patches of hyphae suggest, but there is evidence that the olivaceous crusts of such fungi, formed of brown hyphae creeping beneath the surface, are not always connected with the pycnidia. I have a specimen of *P. nebulosa*, (Pers.), on stems of *Angelica*, which illustrates this point most convincingly; the young pycnidia, surrounded by hyphae, but without spores, being more like *Phyllosticta*, while the mature ones, not surrounded by hyphae and full of spores, are those of a typical *Phoma*. The conclusion is that *P. Siliquastrum*, Desm. is only an accidental form of *P. oleracea*, Sacc., for the spores are the most persistent character of any species.

936. Phoma Pritchardiae, *Cooke & Hark.*

Pycnidia subgregarious, immersed, then erumpent, about 200 μ diam., black, shining, pierced by a pore. Spores narrowly cylindric-ellipsoid, obtusely rounded at both ends, continuous, biguttulate, about 10-12 $\times$ 2 μ (Cooke says 14 $\times$ 3 μ); sporophores subulate, about half as long again. (Fig. 8*a*.)

On *Pritchardia*, California (Cooke, Exs. no. 2167 !).

This species, which was described by Cooke in Grevill. 1884, xii. 93, might well be placed in a regenerated *Macrophoma*, if the futile limit of 15 μ were removed. Judging by the descriptions, the two varieties placed by Saccardo under this species—*coryphea* on *Corypha australis*, and *Phoenicis* on *Phoenix* (Sacc. Syll. x. 181)—do not seem to resemble *P. Pritchardiae* very much, but no specimens have been seen. *Phoma Phoenicis* is probably a *Phomopsis*, but *P. Pritchardiae* is not. *Phoma Coryphae*, Cooke (in Grevill. xix. 75), on Palm petioles, seems to be much nearer to the present species, but is very different in external appearance; unfortunately Cooke's specimen of *P. Coryphae*, on examination, yielded no spores.

937. Phoma Desmonci, *Rabenh.*

Pycnidia scattered or thinly gregarious, arranged mainly along the nerves, 300-450 μ diam., blackish, immersed, then erumpent by the extreme apex or simply raising the epidermis in a white spot, which is surrounded by a faint black stain. Spores cylindric-ovoid, straight or often curved, obtuse at both ends, hyaline, 5 $\times$ 1·5–2 μ.

On leaves of "*Desmoncus melanochaetes*" (= ? *Daemonorops melanochaetes*, Blume) in the Botanic Gardens, Calcutta. *See* Hedwigia, 1878, p. 60. The pycnidia of this species (Rabenh. Fung. Eur. no. 2454 !) are not described in Saccardo's *Sylloge*, vol. iii.

942. Phoma Ornithogali, *Thüm.*

Phoma Ornithogali, Thüm. in Flora, 1878, p. 358 (Thüm. Mycoth. Univ. no. 1783 !; Roum. Fung. Sel. Exs. no. 4749 !).

The description of Thümen (*l.c.*) is very correct, except that in one place, by error, the word "apice" is used instead of "basi"; for the spores are often subclavate; *i.e.*, rounded above, narrowed below, measuring 4–6 $\times$ 1·5–2 μ. This species might almost better be considered as a variety of *Phoma nebulosa*, Mont., which externally Roumeguère's specimens at least exactly resemble.

1008. Phoma chartarum, *Berk. & Curt.*

Phoma chartarum, B. & C. in Grevill. 1873, ii. 83.

Phoma charticola, Speg. Fung. Arg. Pug. no. 99 (1880). Sacc. Syll. iii. 168.

Pycnidia scattered, nearly superficial, subglobose, 90–120 μ diam., black; texture soft, thin, fuliginous-brown (truly *Phoma-*

like), with an impressed ostiole round which the tissue is darker. Spores oblong-ellipsoid, usually obtuse at both ends, often biguttulate, involved in mucus, perfectly hyaline, 4–4·5 × 2 μ. (Fig. 8*c*.)

On soft white paper, Alabama (Beaumont, Herb. Berk. no. 5106 !).

There can be no hesitation in deciding that Spegazzini's species is the same as that of Berkeley : the supposed difference in the size of the spores disappears on examination, and the delicate byssoid subiculum mentioned by Berkeley is not, now at least, apparent in his specimens.

But Cooke's British species (placed under the same name) is quite different. On examining his specimens (Cooke, Fung. Brit. Exs. no. 413 !) on millboard, London, 1875, one finds, in addition to a number of loose spores, a mixture of two forms. One is no doubt a Hyphomycetous stage of the other and, although not now specifically determinable, is obviously an *Aspergillus*. The other is a Pyrenomycete, belonging to the *Perisporieae*, and seems to be absolutely identical with *Cephalotheca Kriegeri*, Rehm (Ascom. Exs. fascic. 44, no. 1850, on white paper : *see* Annal. Mycol. 1909, vii. 405, and Sacc. Syll. xxii. 30). The only possibility of doubt lay in the fact that *no asci* could now be found, but the tendency of the spores to cling together in clusters (such as is known to all mycologists in *Eurotium herbariorum* and other species of that group) at once suggested that they had originally been contained in asci. The latter are known to be very diffluent in many of the *Perisporieae*, and their absence has often led to mistakes in description, as in Cooke's case here and also in Saccardo's *Mycogala parietinum* which is in most cases nothing but *Anixia* (*ascis praetervisis*). Though no specimens of Rehm's were at hand for comparison, the agreement of the British fungus with the account given in *Annales Mycologici* (*l.c.*), in every detail except those concerning the asci, leaves no loophole for hesitation.

Fig 8.—*a*, *Phoma Pritchardiae*, spores; *b*, (upper group) spores from Desmazières' specimen, "*Phoma nitida*," no. 355, (lower group) spores from Roumeguère's specimen, "*Phoma Ammophilae*," no. 3562; *c*, *Phoma chartarum*, spores from Berkeley's specimen, no. 5106; *d*, *Phoma Andrachnes*, spores from Léveillé's specimens.

1012. Phoma Andrachnes, *Lév.*

(*See also* Sacc. Syll. Addit., p. 305.)

Two specimens, issued by Léveillé and named in his own handwriting, one in Herb. Hooker, the other in Herb. Berk.,

were examined, and from these the following description is drawn up :—

Pycnidia epiphyllous, scattered or in little crowded roundish groups, covered by the epidermis, then erumpent, globose, slightly papillate, at length collapsed, black, somewhat shining, 100–150 μ diam., pierced by an apical pore. Spores cylindrical, often curved, rounded at both ends (sausage-shaped), apparently biguttulate, quite colourless, $8 \cdot 5$–$9 \cdot 5 \times 2 \cdot 5\ \mu$; sporophores not seen. (Fig. 8*d*.)

On leaves of *Arbutus Andrachne*, Crimea.

The biguttulate appearance is due, not to the presence of oil-guttules, but to the fact that the protoplasm is retracted to each extremity of the spore, leaving the middle part as a vacuole. This species is similar to *Macrophoma maculiformis*, Sacc. = *Sphaeropsis maculiformis*, Cooke & Harkn., on *Arbutus Menziesii* (*see* Grevill. ix. 82), but has different spores.

After these may be placed a few species which are either indeterminable, or were merely named in error.

905. Phoma nyssocarpa, *Cooke.*

Phoma nyssaecarpa, Cooke, in Grevill. vii. 32.

There is a good supply of the pericarps of these fruits (*Nyssa capitata*), in Rav. Exs. no. 2133 !, covered with clusters of little brownish-black pycnidia (or perithecia), but no trace of spores of any kind could be obtained from them.

907. Phoma pomorum, *Thüm.*

There is no specimen of Thümen's in the Herbarium, but there are several others issued under this name, all of them showing hardly anything but young *Diplodia malorum*, Fckl.

941. Phoma Agapanthi, *Sacc.*

Sphaeropsis Agapanthi, Thüm. Contr. Myc. Lusit. no. 319.

Thümen's exsiccata (*legit* Moller), including the type specimen named in his own handwriting, show little but brown knots of mycelium, accompanied by a quantity of brown creeping threads and numerous loose spores : but no spores were seen attached to hyphae or in pycnidia. It is probably one of those species of *Cladosporium* which form a basal knot to the conidiophores.

945. Phoma macrothecia, *Thüm.*

Phoma macrothecia, Thüm. in Flora, 1876, p. 571 (Thüm. Mycoth. Univ. no. 680 !).

This is nothing but *Darluca*, parasitic on the uredo-sori of *Uredo Moraeae*, Kalch., on leaves of *Moraea grandiflora*, Eckl. = *Homeria collina*, Vent. var. γ, *ochroleuca*, Baker.

948. Phoma microscopica, *B. & Br.*

On Berkeley's original and only specimens of this there is a *Phoma*-like fungus to which it is at present impossible to assign a definite place. The pycnidia are scattered, subglobose, about 150 μ diam., covered by the discoloured epidermis which is darkened around the ostioles, pierced by a pore; texture thin, parenchymatous, pale-brown. Spores oblong-ellipsoid, rounded at the ends, often biguttulate, occasionally curved, hyaline, 7–8 $\times$ 2½–3 μ.

On dying stems of *Potamogeton* (Herb. Berk. no. 44 !). It appears likely to be a young state of an *Ascochyta*, but no *Ascochyta* on *Potamogeton* seems to be recorded. It might be a *Phyllosticta*, but does not agree with those described on that host.

971. Phoma Musarum, *Cooke*, in Grevill, xii. 22.

There are a number of specimens of this, all named by Cooke (Ravenel, no. 3182 !, and Rav. & Cooke, Fung. Amer. Exs. no. 692 !). They consist of what are probably the beginnings of perithecia or pycnidia, but no spores corresponding to Cooke's description "elliptico-elongate, 10 $\times$ 3" could be detected.

993. Phoma linearis, *Sacc.*

Phoma lineata, Sacc. Syll. iii. 860.

Coniothyrium lineare, Thüm. Fung. Amer. Spec. no. 12.

All the specimens under this head, including :—

"*Coniothyrium lineare*, Thüm." (Ravenel, Fung. N. Amer. nos. 2810 !, 2925 !, and Harkness, no. 2212 !)

"*Phoma linearis*, Sacc." (Roum. Fung. Sel. Exs. no. 5767 !) seem to consist of nothing but either knots of mycelium, or young pycnidia or perithecia in which no spores were developed.

1016. Phoma Laricis, *Lév.* (*see* Syll. Addit., p. 306).

This is represented in the Herbarium by a specimen sent to Berkeley, and labelled in Léveillé's own handwriting "*Phoma Laricis*, Lév. in strobil. Laric. Europ.—Tauria."

It is not, however, on scales of Larch, but of *Picea excelsa*, and the examination of the fungus showed that it does not differ from *Sporonema strobilinum*, Desm.

1017. Phoma Podagrariae, *Westd.*

This, as is well-known, is nothing but a young undeveloped state of *Phyllachora Podagrariae*, Karst., and the specimens examined (Roum. Fung. Gall. Exs. no. 913 !) contain as a matter of fact numerous imperfectly formed asci. A reference to Westendorp's description (Bull. Acad. Roy. Belg. 1852) shows that he intended the same thing : but *Phoma Podagrariae*, Bres. is, of course, quite different.

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XVI.—THE COMPOSITION OF THE RHIZOMES OF BRACKEN AND ITS VARIATIONS.

James Hendrick.

During the latter part of the War, when it was necessary to ensure the food supplies of the country to the utmost extent and to examine all substances which were possible sources of food for human beings or live stock, or which might be used instead of food stuffs, for the production of alcohol, acetone and other necessary organic products, I made, under the auspices of the Ministry of Food, some investigations into the composition of the Rhizomes of Bracken, and into the supplies which were available, and the cost of obtaining these. It is well known that these Rhizomes contain considerable stores of starch, and that they have been, at various times and in different parts of the World, used as a source of food for men and animals. The

successful termination of the War a few months after the commencement of the enquiry made the food situation less critical and diminished the necessity for the enquiry, which was officially discontinued. Certain aspects of the results obtained have been dealt with elsewhere,* but in the course of the work some data were obtained which the late Professor Trail considered might be of interest to Botanists, and at his request the following note upon these was prepared.

The enquiry began early in the Spring of 1918, and it was the intention to take samples of the rhizomes at intervals throughout the year to ascertain the variation which took place in their composition with the season, and the best time of harvesting them from the food or starch-production point of view. Among others, samples were taken from two spots in Craibstone, the experimental farm of the College of the North of Scotland College of Agriculture. These two places are both in rough woodland and are within half a mile of one another. The first samples were taken at the beginning of April, and when they were analysed, it was found, that though the percentages of moisture and dry matter respectively were almost identical in the two, the percentage of nitrogen differed so seriously that at first it was supposed some mistake had been made. A repetition of the determination, however, showed that there really was a very great difference in the nitrogen content. The sample " A," taken on April 1st from the West woods had less than half the percentage of nitrogen contained in the sample " B," taken from the woods between Blue Breeks field and the Chapel Park (*see* Table I.), while on the other hand the percentage of soluble Carbohydrates in " A," was considerably greater than that in " B."

The analyses were made by the ordinary conventional methods used for feeding stuffs. The really significant determination is that of nitrogen, and "Albuminoids " are merely conventionally determined by multiplying nitrogen by $6\frac{1}{4}$. As the Soluble Carbohydrates are determined by difference they are necessarily less in sample " B " than in sample " A."

The next samples, A.2 and B.2, were drawn two months later, on the 7th June, when the fronds had developed considerably, and thereafter samples were taken at intervals of a month, or a little more, till March 1919. In all, 10 samples were drawn from each place, and the results of the analyses of these are given in Table I.

The samples are numbered in the Table, and the dates on which the samples were taken were as follows :—No. 3 on July 18th, No. 4 on August 21st, No. 5 on September 25th, No. 6 on October 28th, No. 7 on November 30th, No. 8 on December 27th; all in 1918; No. 9 on February 4th and No. 10 on March 8th in 1919. In all cases the A. and B. samples were collected on the same date.

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* " Bracken Rhizomes and their Food Value," Trans. Highland & Agricultural Society of Scotland, 1919, xxxi., 5th series, pp. 227–236.

TABLE I.—COMPOSITION OF BRACKEN RHIZOMES.

	"A" SAMPLES.										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Av.
	%	%	%	%	%	%	%	%	%	%	%
Moisture	74·60	78·71	76·32	72·89	64·93	71·66	69·87	62·61	70·15	69·24	71·10
COMPOSITION OF DRY MATTER:											
Ether Extract	1·02	·80	1·21	·70	·68	·70	·73	·74	·74	·84	·82
* Albuminoids	8·62	4·73	1·84	6·23	6·24	1·87	1·88	2·86	1·82	5·69	4·18
Soluble Carbohydrates	65·52	58·78	57·01	67·96	68·68	71·82	68·44	71·67	72·25	62·79	66·49
Fibre	17·52	27·36	27·44	18·11	18·79	18·80	22·28	20·00	19·46	26·17	21·59
† Ash	7·32	8·33	12·50	7·00	5·61	6·81	6·67	4·73	5·73	4·51	6·92
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
* Containing Total Nitrogen	1·37	·76	·29	·99	·99	·30	·30	·45	·29	·91	·66
„ Protein Nitrogen	·87	·70	·29	·88	·91	·22	·23	·37	·22	·75	·54
† „ Siliceous Matter	3·86	3·68	9·24	2·21	2·34	3·88	3·17	1·71	2·75	1·46	3·43
Ash, less Siliceous Matter	3·46	4·65	3·26	4·79	3·27	2·93	3·50	3·02	2·98	3·05	3·49

TABLE I.—*continued.*

	"B" Samples.										
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Av.
	%	%	%	%	%	%	%	%	%	%	%
Moisture - - - - - -	74·72	78·18	73·35	74·83	65·01	66·65	68·02	64·45	68·03	68·68	70·19
COMPOSITION OF DRY MATTER:											
Ether Extract - - - -	·95	1·33	·72	1·07	·88	·71	·75	·78	·75	·80	·87
* Albuminoids - - - - -	21·19	18·39	7·54	13·66	11·80	11·75	12·13	12·32	11·78	12·38	13·29
Soluble Carbohydrates - - -	48·30	43·62	50·12	58·86	66·92	58·43	61·39	60·97	59·73	56 62	56·51
Fibre - - - - - - -	20·26	28·23	27·71	19·30	14·40	18·74	19·35	18·90	18·89	21·07	20·68
† Ash - - - - - - -	9·30	8·43	13·91	7·11	6·00	10·37	6·38	7·03	8·85	9·13	8·65
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
* Containing Total Nitrogen - -	3·39	2·94	1·21	2·18	1·88	1·88	1·94	1·97	1·87	1·97	2·12
,, Protein Nitrogen - -	2·88	2·40	1·16	1·94	1·51	1·74	1·79	1·82	1·72	1·66	1·86
† ,, Siliceous Matter - -	5·42	4·25	10·00	2·10	3·57	6·95	3·28	4·05	5·41	5·77	5·08
Ash, less Siliceous Matter - -	3·88	4·18	3·91	5·01	2·43	3·42	3·10	2·98	3·44	3·36	3·57

The Table gives first the moisture found in each sample in its fresh state as it was taken from the ground. The rest of the constituents are calculated on the dry, moisture-free Rhizomes. The average composition of the ten "A" samples and of the ten "B" samples is given. The great difference between the two sets of samples is in the Nitrogen, and, consequently, in the Albuminoids.

In the ten "B" samples the average Nitrogen is 0·62 per cent., or calculated in the dry matter 2·12 per cent., while in the ten "A" samples the Nitrogen is 0·19 per cent., or, calculated in the dry matter, 0·66 per cent. The Nitrogen, therefore, in the "B" samples is more than three times as great as in the "A" samples. The difference, too, is found in every individual pair of samples, though in the samples taken in September the one is only about twice as great as the other, while in the samples taken in November and February the difference between them is nearly as 8 to 1.

During the first few months of sampling, the variations in both sets of samples were very much what was expected. With the development of the fronds, the store of Nitrogen in the Rhizomes diminished seriously, and the percentage in both "A" and "B" reached a minimum in July, when the frond reached its maximum development. After that, the Nitrogen increased again and soon reached a maximum. Having developed its frond, the plant appears to build up again quickly its store of nitrogenous material in the Rhizomes. This has a bearing on the important economic problem of the best time to cut bracken, when it is desired to rid land of it. The nitrogen content of the Rhizome appears to be at its lowest just when the frond is fully developed, and if cut then, the Rhizome will be left with very limited supplies of nitrogenous materials.

In both "A" and "B" the new maximum percentage of Nitrogen in the dry matter is reached in August. After that, the percentage in the "B" samples falls a little, but remains as nearly constant throughout the late autumn and winter as could be expected in a number of different samples such as these. The small diminution of the percentage of Nitrogen in the late summer might easily be accounted for by the increase in Carbohydrates due to the Carbohydrate deposition at that time being proportionately greater than that of nitrogenous material. But it is more difficult to account for the great falling off in the nitrogen percentage in the "A" samples. In February the percentage is exactly the same as the minimum in July, and in October and November it is very little greater, but there is this noticeable difference, that whereas in July the Nitrogen was all Protein Nitrogen, in all the other months there is a very appreciable proportion of non-protein Nitrogen present.

A somewhat similar phenomenon is to be noted in the "B" samples in which the non-protein Nitrogen is much lower in July than at any other period of the year. The percentage of Nitrogen in the "A" samples varies widely from month to

month in a fashion for which I am unable to offer any explanation. For instance, it is practically 1 per cent. of the dry matter in August and September, but falls to 0·3 per cent. in October and November, rises somewhat in December but falls again in February, only to rise again suddenly to nearly 1 per cent. in March. All these figures were fully confirmed. The only suggestion I can make is that in the low Nitrogen " A " samples there were great variations in the Nitrogen content from spot to spot. But the whole of the samples were in each case taken from an area of about 12 square yards, and each sample consisted of practically all the pieces of Rhizome found in an area of about a square yard.

It is to be noted that in both the " A " and " B " samples the percentage of Nitrogen found at the beginning of the growing season in early April 1918 was considerably higher than that found in any other sample at any time of year. The samples taken nearly a year later in early March 1919 did not in either case contain nearly so high a percentage of Nitrogen. This may have been an effect of season. The outstanding difference between the two sets of samples is the radical difference between the percentage of Nitrogen all through the season. There are no great differences in other aspects. The moisture in the two sets of samples is very similar and varies somewhat similarly during the season. In both it increases from April to June, falls throughout the summer, then rises slightly and falls again to its minimum in December and again rises considerably in February and March.

The " Soluble Carbohydrates " also vary somewhat similarly in both with the season, though for the reason already stated they are always lower in the " B " samples, which are rich in nitrogeous matter, than in the " A " samples. As might be expected, they fall to a minimum in June, then increase throughout the summer when the frond has developed and carbon assimilation is active. The fibre also varies on somewhat similar lines in the two series of samples throughout the season, and is on the average nearly the same in the two. The Ash is made up of two parts, the genuine Ash of the rhizomes, and siliceous matter derived from the soil which is accidently present. If we deduct this siliceous matter, the average ash in each of the sets of samples amounts to almost exactly 1 per cent. of the original rhizomes or $3\frac{1}{2}$ per cent. of the dry matter, and though it varies somewhat irregularly from month to month it exhibits no features calling for special mention. The " Ether Extract " also, which amounts on the average to between ·8 and ·9 per cent. in both sets of samples, shows no special features calling for comment. Why then should the Nitrogen content exhibit such a remarkable difference ?

The late Professor Trail examined both the rhizomes and fronds and reported that he could find no botanical differences between the bracken growing at the two places and that both

appeared to be normal *Pteris aquilina*. This disposed of a suspicion which had occurred to me that I might be dealing with two different species or varieties.

Analyses were also made of the fronds at different periods during the summer and autumn, and the results are given in Table II.

The fronds developed later at " A," the West Woods, than at " B," the wood between the Chapel Park and Blue Breeks. The first samples from " B," No. 1 in the Table, were gathered on May 9th when they were from 2 to 12 in. high and just beginning to uncurl. The corresponding samples from " A " were not taken till three weeks later, May 30th, and were even then only about 6 in. high and still curled. Both are high in moisture and relatively high in Nitrogen, and at this stage the Nitrogen is higher in the " A " sample than in the " B " sample.

The next samples were taken on June 18th, No. 2 in the Table, when the fronds at both places ranged up to 3 ft. in length. Those at " B " however were larger and better developed than those at " A," which were relatively small and narrow. The " B " fronds were at this time considerably richer in Nitrogen and they also contained a distinctly higher percentage of moisture. It is noticeable that at this stage the non-protein Nitrogen is lower than at any other. This was an unexpected result, as, judging from general experience with Plant Analysis, one expected the proportion of non-protein Nitrogen to be considerable in an immature leaf.

The next samples were taken on September 25th, when the fronds were turning yellow. Those at " A " were already almost completely yellow, while those at " B " were only yellow here and there. Though the " A " fronds developed later, they turned yellow earlier. The two places are at nearly the same altitude, about 300 ft. above sea level, but " A " is more exposed than " B," which is well sheltered.

In these samples there is a great difference in Nitrogen, and the " A " sample is again considerably lower in percentage of moisture than the " B " sample. In both cases the proportion of non-protein Nitrogen is greater than in any of the other samples.

The final samples were taken on October 28th when the fronds were dead and brown at both places. The difference in Nitrogen persists in these dead fronds, those from " B " having almost exactly twice the percentage which was found in those from " A."

Except the differences in Nitrogen and moisture, no other striking dissimilarity was found between the two sets of samples, and the fronds therefore, after they are developed, exhibit much the same peculiarity as the rhizomes, in that those from " B " are much richer in nitrogenous matter than those from " A."

Samples of the soil were taken from both places to see if they exhibited any remarkable differences in Nitrogen content, or otherwise, which might throw light on the differences found in the

TABLE II.—COMPOSITION OF BRACKEN FRONDS.

	"A" Samples.				"B" Samples.			
	1.	2.	3.	4.	1.	2.	3.	4.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Moisture	90·39	69·55	62·90	19·20	90·23	74·27	70·27	18·42
COMPOSITION OF DRY MATTER.								
Ether Extract	2·39	3·14	2·53	1·69	2·94	4·33	2·45	1·97
* Albuminoids	27·73	15·59	3·37	3·40	25·15	21·58	7·56	6·74
Soluble Carbohydrates	41·09	50·35	52·38	44·34	44·76	46·29	48·62	42·46
Fibre	13·17	24·50	34·66	44·34	15·86	20·66	33·97	42·88
† Ash	15·62	6·42	7·06	4·65	11·29	7·14	7·40	5·95
	100·00	100·00	100·00	100·00	100·00	100·00	100·00	100·00
* Containing Total Nitrogen	4·44	2·48	·54	·54	3·99	3·46	1·21	1·07
Containing Protein Nitrogen	3·69	2·43	·38	·45	3·58	3·42	·90	·91
† Containing Siliceous Matter	·73	·52	2·83	2·69	1·08	·43	1·85	2·30

bracken. Both soils are typical sour, moorish soils, and the results of their partial analysis are shown in Table III.

TABLE III.—PARTIAL ANALYSIS OF SOILS.

	"A."	"B."
	West Woods.	Wood between Blue Breeks Field and Chapel Park.
	Per cent.	Per cent.
Loss on Ignition (Humus, etc.)	42·65	26·85
Total Nitrogen	·55	·57
Nitrogen as Nitrate	absent	absent
Nitrogen as Ammonia	·001	·001
Lime Requirement, as $CaCO_3$	1·53	1·30

The soil from "A" was nearly free from stones and gravel. The coarse materials which failed to pass a sieve with round holes 1 millimetre in diameter were less than 2 per cent. On the other hand, the soil from "B" was stoney, and almost 29 per cent. of the sample consisted of stones and gravel which failed to pass the 1 mm. sieve. The determinations shown in Table III. were made in the fine earth which passed this sieve. Both soils were found to be very sour. By Truog's test, both gave an acidity comparable to that of a pure peat, but "A" was found to be distinctly more acid than "B." On the other hand, the determination of "Lime Requirement" by Hutchinson & Maclennans* method (*see* Table III.) shows that it requires more Carbonate of Lime to neutralise "B" than "A," but it also shows that both are very sour soils. An ordinary soil will weigh, dry, approximately 1,000 tons per acre to a depth of 9 in., and for a soil of this weight the figures mean that it would require 15·3 tons of Carbonate of Lime to neutralise "A" and 13·0 tons to neutralise "B." Such quantities are never applied now-a-days in agricultural practice, but, on the other hand, such moorish soils as these weigh light, and would not have a dry weight of 1,000 tons per acre 9 in. deep. Little information is to be gained from the figures for total Nitrogen, as both soils contain almost the same percentage, and that much what might be expected from soils of this class.

Finally there is the difference in situation of the two places. "A" is on an open hillside from which the trees were removed some time ago, and it is therefore exposed and free from shade. "B" on the other hand is a well sheltered hollow, where the Bracken is both sheltered from wind and shaded by trees. In

* Journal of Agricultural Science, 1915, vii. pp. 75–105.

this shaded hollow the Bracken grows more luxuriantly than at "A." The fronds grow larger, and are broader and more vigorous. In the more exposed situation at "A" the Bracken grows vigorously, but, as already stated, the fronds come later and go earlier, and they are somewhat smaller and distinctly narrower and harder than at "B." This difference in situation is the only real difference which has been found which I can suggest as the cause of the difference in composition found in the plants taken from the two places, and it hardly appears to be a satisfactory explanation for so remarkable a difference in Nitrogen content.

XVII.—DATURICARPA, A NEW GENUS OF APOCYNACEAE.

O. Stapf.

A few months ago Dr. E. De Wildeman submitted to me for examination some material of Apocynaceous plants which had accumulated in the Herbarium at Brussels during recent years, being found unreducible to any described genus of the family. The structure of the fruit showed undoubtedly novel characters. The habitus and general aspect of the flowers pointed to *Tabernanthe* and *Pterotaberna*, but the structure of the anthers differed essentially from that obtaining in either genus and was practically the same as in *Carvalhoa*, from which it differs, however, in the corolla and to some extent in the habitus. There are three and possibly four species discernible, all closely allied and forming together a well defined and homogeneous group which may be proposed as a new and distinct genus, *Daturicarpa*, a name which speaks for itself.

Daturicarpa, *Stapf*, gen. nov. (Apocynaceae—Tabernaemontaneae); affinis *Carvalhoae*, K. Schum., sed corolla plane hypocraterimorpha, antherarum connectivo basi antice calloso piloso, praecipue vero mericarpiis bacciformibus undique verrucis vel spinis mollibus obtectis distincta.

Calyx parvula, herbacea, intus eglandulosa (vel interdum pauciglandulosa ?); sepala 5, sublibera, imbricata, ovata, eciliata. *Corolla* hypocraterimorpha; tubus basi leviter ampliatus, e medio sursum sensim angustatus, ore exappendiculatus, intus pone antheras lineis pilosis singulis notatus; lobi latiusculi, obtusi, sinistrorsum contorti, in alabastro haud inflexi. *Stamina* medio tubo inserta; antherae in conum conniventes, in tubo inclusae, stigmati haud vel vix agglutinatae, lineari-sagittatae, acuminatae, caudis longiusculis incurvis acutis, dorso glabrae, connectivo ima basi postice ac antice calloso et hic laxe piloso, thecarum parte pollinifera parti sterili laevi fere aequali. *Discus* indistinctus, ovario adnatus, carnosulus. *Carpella* 2, basi excepta libera, sensum in stylum filiformem abeuntia; stigma capitatum, breviter apiculatum, basi anguste manicatum, leviter 5-sulcatum,

FIG. I.

Daturicarpa lanceolata.

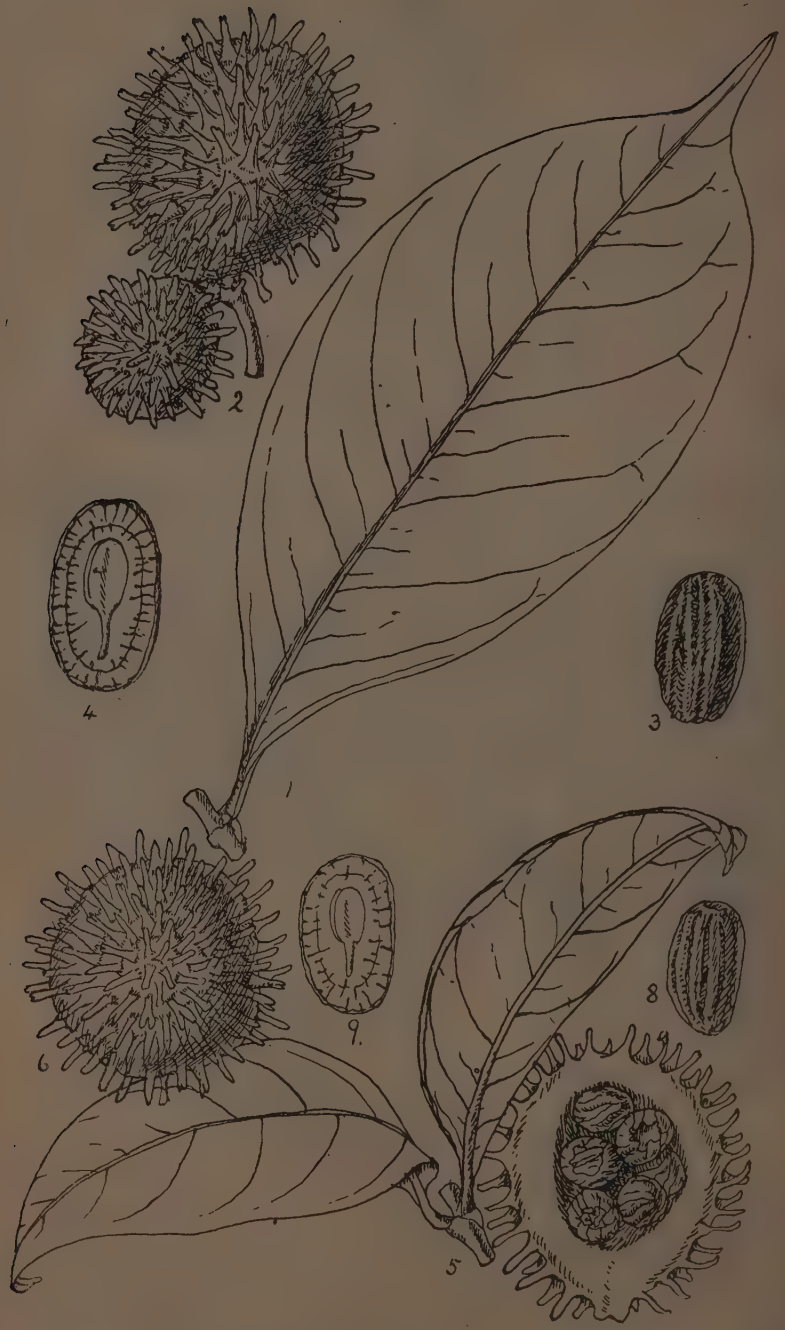

FIG. II.

1–4, Daturicarpa elliptica, 5–9, D. firmula.

subviscosum; ovula 3–5-seriata. *Mericarpia* quorum unum saepe hebetatum vel abortivum, indehiscentia, bacciformia, globosa vel subglobosa, undique verrucis elongatis vel spinis mollibus obtecta (more *Daturae*, unde nomen), cortice subcoriaceo et tunc interdum crasso, raro tenui. *Semina* ad 20 (rarius plura), ellipsoidea in pulpa mucilaginosa nidulantia; testa crassiuscula, spongioso-coriacea, longitudinaliter costata costis transverse rugulosis; endospermium ruminatum, subosseum. *Embryo* cotyledonibus radiculae subaequilongis planis latis.—Frutices vel arbusculae latescentes, glaberrimae, furcato-ramosae, ramis annotinis cortice pallido laevi vel verrucoso et rugoso-striato. Folia opposita, papyracea, laxe nervosa, breviter petiolata; petioli ramis basi acute triangulari insidentes, intus glandulis numerosis stipati. Flores in paniculas sparsifloras breves e furcis ramorum junioribus ortas dispositi, parvuli albidi vel viridi-flavescentes, tubo 6–7 mm. longo, limbo aperto 7–8 mm. diametro. Fructus ochracei vel aurantiaci vel atro-virescentes, plerumque unus inflorescentiae ad maturitatem perveniens axi indurato ramulum referente suffultus.

Species 3–4, omnes Congolensis.

Folia tenuia :

Folia saturate viridia, lanceolata, longe sensim acuminata, acumine acuto, 10–15 cm. longa, 2·5–5 cm. lata, nervis lateralibus utrinque circiter 7; rami plerumque laeves; mericarpia ellipsoideo-globosa, 2·5 cm. longa, atro-olivacea, cortice mediocri ... ... 1. *D. lanceolata.*

Folia pallide viridia (praesertim subtus), late elliptica vel elliptico-oblonga, abrupte caudato-acuminata, acumine lineari obtusiculo, 10–18 cm. longa, 5·5–7 cm. lata, nervis lateralibus utrinque 6–7; rami rugoso-striati et lenticellato-verrucosi, mericarpia globosa, 3·5 cm. diametro, aurantiaca, cortice crasso ... 2. *D. elliptica.*

Folia firmula, lanceolata, 5–10 cm. longa, 1·5–3·5 cm. lata, nervis lateralibus utrinque 5; rami rugoso-striati et lenticellato-verrucosi; mericarpia circiter 2 cm. diametro, atro-olivacea, cortice mediocri 3. *D. firmula.*

Explanation of Text Figures I. & II.

I. *D. lanceolata;* 1, part of branch with a pair of leaves and an inflorescence x. 1; 2, flower, x. 5; 3, calyx flattened out, x. 10; 4, corolla tube, longitudinal section, x. 5; 5, stamen, x. 16; 6, pistil, x. 5; 7, a carpel in transverse section, x. 20; 8, a pair of fruits, only one follicle developed in each case, x. 1; 9, fruit, cut open, x. 1; 10, seed, x. 4; 11, same in longitudinal section. II. 1–4, *D. elliptica*: 1, leaf, x. 1; 2, fruit with unequal follicles (note the short stipes above the calyx)' x. 1; 3, seed, x. 4; 4, seed in longitudinal section, x. 4; 5–9, *D. firmula*: 5, pair of leaves, x. 1; 6, fruit (mericarp), x. 1; 7, same, cut open, x. 1; 8, seed, x. 4; 9, same in longitudinal section.

1. **D. lanceolata,** *Stapf* (sp. nov.). *Frutex* ramis annotinis laevibus vel sublaevibus, rarius hinc inde lenticelloso-verrucosis. *Folia* lanceolata, longe acute acuminata, basi acuta, pleraque 10–15 cm. longa, 2·5–5 cm. lata, tenuiter papyracea, exsiccando supra saturate viridia, subtus pallidiora, nervis lateralibus utrinque circiter 7; petioli circiter 7 mm. longi, basibus oppositorum lateraliter haud obviis linea prominula transversa junctis. *Paniculae* pedunculo 1–2 cm. longo incluso ad 4 cm. longae. *Sepala* late ovata, acuta, interdum sub-denticulata. *Corolla* albida. *Mericarpia* ellipsoideo-globosa, pedunculo recurvo vel pendulo ad 4 cm. longo suffulta, atro-olivacea, spinis mollibus 5–7 mm. longis creberrimis tecta, cortice 1–2 mm. crasso, spinis 5–7 mm. longis. *Semina* probabiliter ultra 10, 5–6 mm. longa.

Belgian Congo.—Province Orientale; near Stanleyville on wooded river banks, *Bequaert*, 7058.

2. **D. elliptica,** *Stapf* (sp. nov.). *Frutex* vel arbuscula, ramis annotinis crebre rugoso-striatis et lenticellato-verrucosis. *Folia* late elliptica vel elliptico-oblonga, abrupte caudato-acuminata acumine lineari obtusiculo, 10–18 cm. longa, 5·5–7 cm. lata, admodum tenuia, supra viridia vel exsiccando fuscescentia, subtus pallida, nervis lateralibus utrinque 6–7; petioli 3–6 mm. longi, basibus oppositorum lateraliter plerumque sub angulo acuto obviis. *Paniculae* pedunculo circiter 5 mm. longo incluso ad 3 cm. longae. *Sepala* ovato-rotundata, obtusa vel subobtusa. *Corolla* viridi-flavescens ore rubro-striata. *Mericarpia* pedunculo 1–2 cm. longo patulo vel erecto suffulta, globosa, ad 3·5 cm. diametro, rubro-ochrea vel aurantiaca, spinis mollibus 7–10 mm. longis creberrimis tecta, cortice 3 mm. crasso. *Semina* ad 20, 7–9 mm. longa.

Belgian Congo.—Kwango District; Kikwit, *Vanderyst*, 3044. Equateur, Mondombe, Nov. 1917, *Jespersen*. Province Orientale; in virgin forest near Lubutu-Kirundu, *Bequaert*, 6843. Kasai District; Batempa, *Lescrauvaet*, 353; Kondue, *E. & M. Laurent*, 17.

3. **D. firmula,** *Stapf* (sp. nov.). *Frutex* ramis annotinis arcte rugoso-striatis, lenticellato-verrucosis. *Folia* lanceolata, acute vel subobtuse acuminata, basi acuta, pleraque 5–10 cm. longa, 1·5–3·5 cm. lata, firmule papyracea, exsiccando supra atrofusca, subtus fusco-viridia, nervis utrinque circiter 5; petioli 2–4 mm. longi, basibus oppositorum lateraliter sub angulo acuto magis minusve obviis. *Paniculae* pedunculo 1 cm. longo incluso ad 2·5 longae. *Sepala* rotundato-ovata, obscure denticulata, obtusa. *Corolla* colore ignoto, exsiccando flavescens; *Mericarpia* pedunculo 2 cm. longo recurvo suffulta, fusco vel atro-olivacea, globosa, 2 cm. diametro, spinis mollibus brevibus (2–3 mm. longis) crebris tecta, cortice vix 2 mm. crasso. *Semina*, ut videtur, circiter 10, 6–8 mm. longa.

Belgian Congo.—Equateur; Moma, *Jespersen*.

A specimen collected by Claussen in the neighbourhood of Bombaie near Lusambo (?) also belongs here, but the capsule attached contains fruits with a thick shell like those of *D. elliptica* and several leaves of *D. firmula* as well as a fragment of a leaf of *D. elliptica*.

A further species, characterised by small mericarps (not quite 2 cm. in diameter) with a thin, in the dry state, transparent cortex, seems to be represented by a specimen collected by E. Laurent by the Sankuru river in December 1895.

He describes it as a small tree. There are no flowers with it, but a fragment of an infructescence is attached to the stem. This seems to have borne two fruits and its axes are much less lignified than those of the other species. The leaves are very thin, oblong to lanceolate-oblong and caudate-acuminate, gradually attenuated at the base and 8–12 cm. by 3–4·5 cm., with a petiole about 1 cm. long.

XVIII.—MISCELLANEOUS NOTES.

Mr. O. T. Faulkner, B.A., Dip. Agric. (Camb.), late Deputy Director of Agriculture, Lyallpur, Punjab, India, has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Director of Agriculture, Nigeria, and Mr. R. Swainson-Hall, F.L.S., who has spent some years on plantations in the Portuguese Congo, Mr. H. B. Waters, B.A. (Oxon.), Mr. H. Roebuck, N.D.A. (Leeds) and Mr. J. M. Lonsdale, who has had previous agricultural experience in India, as Agricultural Superintendents in the Department of Agriculture, Nigeria.

The following appointments in the Agricultural Department of the Gold Coast have been made by the Secretary of State for the Colonies, on the recommendation of Kew :—

Lt.-Col. A. Ogilvie, N.D.A. (Edin.) and Mr. C. H. Knowles, Superintendent of Agriculture, Fiji, Senior Superintendents of Agriculture.

Mr. H. J. Horwood, B.A. (Oxon.), Mr. A. W. Paterson, N.D.A. (Edin.) and Mr. J. Steele, N.D.A., Assistant Superintendents of Agriculture.

Mr. M. Vardy, Assistant Superintendent of Agriculture, Grenada (see *K.B.* 1920, p. 71) and Mr. A. A. L. Smith of the Royal Botanic Gardens, Edinburgh, Supervisors of Fruit and Vegetable Farms.

Mr. T. D. Maitland, Chief of the Economic Plants Division, Kenya, has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Botanist in the Agricultural Department, Uganda.

Mr. C. C. T. Sharpe, of the Imperial College of Science and Technology, has been appointed by the Secretary of State for the Colonies on the recommendation of Kew, Plant Import Inspector, Kenya Colony, and Mr. F. B. Booker, a Field Assistant, attached to the Laboratories of the Chemical Research Department.

Mr. B. G. C. Bolland, B.A. & Dip. Agric. (Camb.), lately Botanist in the Ministry of Agriculture, Egypt, has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Assistant Director of the Amani Institute, Tanganyika Territory.

Mr. E. Brand, Mr. A. E. Haarer, Mr. R. J. Lathbury, B.A., and Mr. A. Pitcairn, N.D.A. (Edin.) have been appointed District Agricultural Officers in the Department of Agriculture, Tanganyika Territory.

Miss E. J. Welsford, M.B.E., F.L.S., has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, as Mycologist to the Agricultural Department, Zanzibar, and Mr. Graham Tomson has been appointed Inspector of Plantations.

Mr. F. J. Cook, a member of the gardening staff of the Royal Botanic Gardens, has been appointed Assistant Gardener at the National Botanic Gardens, Kirstenbosch, S. Africa.

Mr. H. O. Iliffe, B.A. & Dipl. Agric. (Camb.), has been appointed by the Secretary of State for the Colonies, on the recommendation of Kew, Economic Botanist in the Department of Agriculture, Ceylon.

The following appointments in the Straits Settlements and in the Agricultural Department of the Federated Malay States have been made by the Secretary of State for the Colonies, on the recommendation of Kew :—

Mr. G. A. Best, a member of the gardening staff of the Royal Botanic Gardens, Assistant Curator of the Botanic Gardens, Singapore, and Mr. J. Fairweather, N.D.A. (Leeds) an Assistant Agricultural Inspector, Straits Settlements.

Mr. F. R. Mason, Dipl. Agric., as Assistant Mycologist, Mr. M. R. Henderson, B.Sc. (Aberdeen), as Systematic Botanist, Mr. A. A. Campbell, B.Sc. (Edin.), Mr. J. L. Minto & Mr. G. E. Mann as Assistant Agricultural Inspectors and Mr. E. Farquharson, N.D.A., an Assistant Agriculturist, Federated Malay States.

War Memorial to Kew Employees.—On Wednesday, May 25, a Memorial to the men of the Royal Botanic Gardens, Kew,

who lost their lives during the late war, was unveiled by the Director. It is erected on the back wall of the Temple of Arethusa, between the Victoria Gate and Museum No. 1, and takes the form of a three-panelled tablet in bronze designed and executed by Sir Robert Lorimer, A.R.A.

The idea of erecting such a tribute originated with the Kew Guild, an association of past and present members of the technical and administrative staff of the Gardens. Other members of the Gardens' staff, who are not qualified for membership of the Guild, wishing to join issue, the Memorial became the general token of honour to their dead comrades of the whole staff and of past and present Student Gardeners.

At the head of the central panel, immediately below a crown and scroll, are the words "To the Glory of God, and the Honour and Memory of the Members of the Kew Guild and Staff of the Royal Botanic Gardens, who gave their lives in the War—1914–1919," whilst at the base are the words "Floreat Kew," the motto of the Kew Guild.

On the three panels are enumerated the following 37 names of men, some of whom left Kew direct to join H.M. Forces, whilst others either hurried home from distant Colonies and Foreign Countries to join home contingents, or threw in their lot with the Armies of their adopted countries :—

L./Cpl.	Charles Henry Anderson, A.M.	London Scottish.
Private	Arthur Edwin Baggs ...	Canadian Seaforth Highlanders.
,,	Charles Frederick Ball ...	Royal Dublin Fusiliers.
2nd/Lt.	John Charles Beswick ...	Royal Lancaster Regiment.
Private	Charles Hubert Brown ...	Royal Garrison Artillery.
,,	John Mackenzie Campbell	Canadian Beavers Battalion.
Gunner	James William Clark ...	Royal Marine Artillery.
Sergt.	Sidney George Cobbold ...	Rifle Brigade.
L./Cpl.	Harry Sydney Cockcroft ...	Military Foot Police.
Private	Ernest Richard Collins ...	Middlesex Regiment.
,,	Sidney George Comer ...	Tank Corps, U.S.A.
Sergt.	John Dear	East Surrey Regiment.
Capt.	Charles Leopold Digoy, Ch. Leg. Hon., Rus. Cross, St. Ann	French Infantry.
Rifl.	John Divers	Queen Victoria Rifles.
Sergt.	George Douglas	Tank Corps.
L./Cpl.	Arnold Edmund Duley, M.M.	Somerset Light Infantry.
Private	Gordon Farries	Argyll & Suth. Highlanders.
,,	James Garnett	Wiltshire Regiment.
Sergt.	John Giles	Canadian Victoria Fusiliers.
Private	Joseph Hayhurst	Border Regiment.
Sergt.	Frederick Honey	East Surrey Regiment.

Seaman	John Knowles Jackson ...	Royal Navy.
Private	William Lorimer Joyce ...	South Wales Borderers.
,,	Henry James Longhurst ...	Kings Royal Rifles.
Pioneer	Percy Thomas Martin ...	Royal Engineers.
Rifl.	Arthur John Meads	Queen's Westminsters.
Private	Walter Henry Morland ...	Royal Scots.
Gunner	Frederick T. Purssell ...	Royal Field Artillery.
2nd/Lt.	Munro Briggs Scott	Royal Scots.
Gunner	Robert Service	Canadian French Mortar Brigade.
Sergt.	Henry James Smith	East Surrey Regiment.
,,	Herbert William L. Southgate	Norfolk Regiment.
Major	John Leonard Veitch, M.C....	Devon Regiment.
L./Cpl.	Frank Windebank	East Surrey Regiment.
Sign.	John Nicholls Winn	Civil Service Rifles.
Cpl.	Herbert Martin Woolley ...	Essex Regiment.
Private	Albert Wright	Warwickshire Regiment.

These men belonged to all ranks from the scientific to the labourer staff, but the percentage of the advanced Student Gardener is singularly heavy. Of this class, ten were Subforemen; all joined the Colours but five only lived to return. Where so many men nobly gave their all, it may seem invidious to single out one name for special mention, were it not felt that his dead comrades would have been the first to wish it in the case of L./Cpl. Charles Henry Anderson, who lost his life by a deed of which his Captain wrote "There has not been a grander act of heroism in the war." Briefly, an ignited bomb fell in a dug-out in which he and a number of men were congregated. He immediately picked it up and, pressing it to his body, made for the door; it exploded, but he managed by sacrificing himself to save his friends from all but minor injury. For this act he was posthumously awarded the Albert Medal of the First Class.

The unveiling ceremony commenced with explanatory remarks by the Director, Sir David Prain, followed by the reading of the Roll of Honour by the Chairman of the Committee of the Kew Guild, Mr. C. H. Curtis, and the formal handing over of the Memorial to the Director; then followed the reading of a portion of Ecclesiasticus, 44, by the Assistant Director, Captain A. W. Hill; the termination being the acceptance and unveiling of the Memorial, and an address by the Director.

About 150 near relatives of the dead and representatives of the various sections of the Kew Staff with numerous past Kew men were present at the ceremony, whilst the Ministry of Agriculture was represented by Mr. G. F. Middleton and H.M. Office of Works by Mr. G. D. Patterson.

Semiaquilegia ecalcarata.—Three different species have borne the name *Aquilegia ecalcarata*. Steudel, Nomencl. ed. 2, i. p. 115 (1840), recorded *A. ecalcarata*, Hortul. as a synonym of *A. vulgaris*, Linn.; the publication of this *A. ecalcarata* is invalid because it was cited in synonymy, and was based on an abnor-

mality (International Rules, Art. 37 and 51). Maximowicz gave the name *A. ecalcarata* in 1889 to a new spurless columbine from Kansu and Szechuan (Fl. Tangut. p. 20, t. 8, fig. 12). Two years later Miss Eastwood used it for a new spurless columbine from Colorado (Zoe, ii. p. 227). *A. ecalcarata*, Maxim., and *A. ecal carata*, Eastw., have recently been transferred to the genus *Semiaquilegia*, as *S. simulatrix* and *S. Eastwoodiae* (*Kew Bull.* 1920, p. 165). Maximowicz's species should, however, in accordance with the International Rules, if retained in *Semiaquilegia*, bear the name *S. ecalcarata*, Sprague et Hutchinson (comb. nov.). According to the late Mr. Reginald Farrer, it is abundant in alpine woods and backwoods in Kansu. Plants of *S. ecalcarata* have been raised from seed of Farrer no. 280 by Major F. C. Stern, Goring-by-Sea, Sussex.—T. A. S. and J. H.

The generic name Wikstroemia.—Three different genera, belonging to as many families, have been given the name *Wikstroemia*, in commemoration of the Swedish botanist Johan Emanuel Wikström, the author of a dissertation on *Daphne* (1817), a flora of Stockholm (1840) and other works. *Wikstroemia*, Schrad. (1821) is synonymous with *Haemocharis*, Salisb. (*Laplacea*, H.B.K.), one of the *Ternstroemiaceae*; *Wikstroemia*, Spreng. (1826) has been reduced to *Eupatorium*, Linn. (*Compositae*); and *Wikstroemia*, Endl. (1833), a genus of *Thymelaeaceae*, has been placed on the list of Nomina conservanda, provided for in Art. 20 of the International Rules of Nomenclature.

Some misunderstanding seems to have arisen as to the interpretation of Art. 20, the official (French) text of which reads as follows :—" Art. 20. Toutefois, pour éviter que la nomenclature des genres ne subisse par l'application stricte des règles de la nomenclature, et en particulier du principe de priorité à partir des dates données a l'art. 19, un bouleversement sans avantages, les règles prévoient une liste de noms qui doivent être conservés en tous cas. Ces noms sont de préférence ceux dont l'emploi est devenu général dans les cinquante ans qui ont suivi leur publication, ou qui ont été utilisés dans les monographies et dans de grands ouvrages floristiques jusqu'en 1890." This explicitly states that names included in the list are to be retained *in any event*, being exempted from the operation of the other Rules in so far as these would involve their rejection. Owing to the Nomina conservanda having been published in tabular form with Nomina rejicienda placed in a parallel column, the idea seems to have gained acceptance that they were only retained conditionally, being preferred merely to the Nomina rejicienda cited, but this view is precluded by the wording of Art. 20. *Wikstroemia* is a case in point. Blake has pointed out that the generic name *Haemocharis*, Salisb. was not effectively published, being unaccompanied by a description, and that the next name for this genus in order of priority is *Wikstroemia*, Schrad., which antedates *Laplacea*, H.B.K.* He concludes that, under the International

* Contrib. Gray Herb. liii. p. 36 (1918).

Rules, *Wikstroemia*, Schrad. should replace *Haemocharis*, and that consequently *Wikstroemia*, Endl., although it is a nomen conservandum, should be superseded by *Capura*. But it was with the express object of preventing such disadvantageous changes that Art. 20 was framed, and the wording of Art. 15 indicates that its operation is suspended whenever it conflicts with Art. 20. "Art. 15. Each natural group of plants can bear in science only one valid designation, namely the oldest, *provided that it is in conformity with* the rules of nomenclature and *the conditions laid down in articles* 19 *and* 20 *of section* 2." *Wikstroemia*, Schrad., would therefore be valid under Art. 15 but for the fact that *Wikstroemia*, Endl., is a nomen conservandum under Art. 20, which takes precedence. The generic names *Haemocharis*, Salisb., and *Wikstroemia*, Schrad., being thus unavailable, the ternstroemiaceous genus in question should be called *Laplacea*, H.B.K.

So much inconvenience has been caused in the past by the use of the same name for different genera, that it has seemed worth while to discuss the case of *Wikstroemia* in detail. It is desirable that no uncertainty should exist as to the interpretation of the International Rules.

It may be added that Schrader and Endlicher both used the spelling *Wickstroemia*, which was corrected by subsequent authors.

T. A. S.

"Bothalia."*—The Division of Botany and Plant Pathology of the Union of South Africa has issued the first part of a new work under this title, in memory of the first Union Premier and Minister of Agriculture, the late General Botha. It is edited by the energetic Chief of the division, is intended as a medium for the publication of papers and monographs based on the material in the National Herbarium, Pretoria, and will contain information regarding the vegetable resources of the country, its plant poisons and plant pests. The department is therefore now well supplied with means for the publication of results of the botanical investigation of the country, issuing in addition the "Flowering Plants of South Africa" (*Kew Bull.* 1920, 374), and its "Memoirs of the Botanical Survey" (*Kew Bull.* 1920, 139). We understand the new work will be published as occasion demands. The first part is devoted to the following papers:—"South African Ascomycetes in the National Herbarium," by Ethel M. Doidge; "The Genus *Bersama*" and "The Natal Species of *Sapindacae*," by E. P. Phillips; and "A Revision of the African Species of *Sesbania*," by E. P. Phillips and J. Hutchinson.—J. H.

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* "Bothalia," A Record of Contributions from the National Herbarium, Union of South Africa, Pretoria, edited by I. B. Pole Evans; vol. 1. pt. i, pp. 64, price 7*s*. 6*d*.—Pretoria, The Government Printing and Stationery Office, 1921.

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